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SOIL SURVEY

OF THE

FREDERICTON-GAGETOWN AREA NEW BRUNSWICK

BY

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FIRST REPORT OF THE NEW BRUNSWICK SOIL SURVEY

EXPERIMENTAL FARMS SERVICE, DOMINION DEPARTMENT OF AGRICULTURE IN CO-OPERATION WITH THE NEW BRUNSWICK DEPARTMENT OF AGRICULTURE

hed by authority of the Hon. JAMES G. GARDINER, Minister of Agriculture,
Ottawa, Canada

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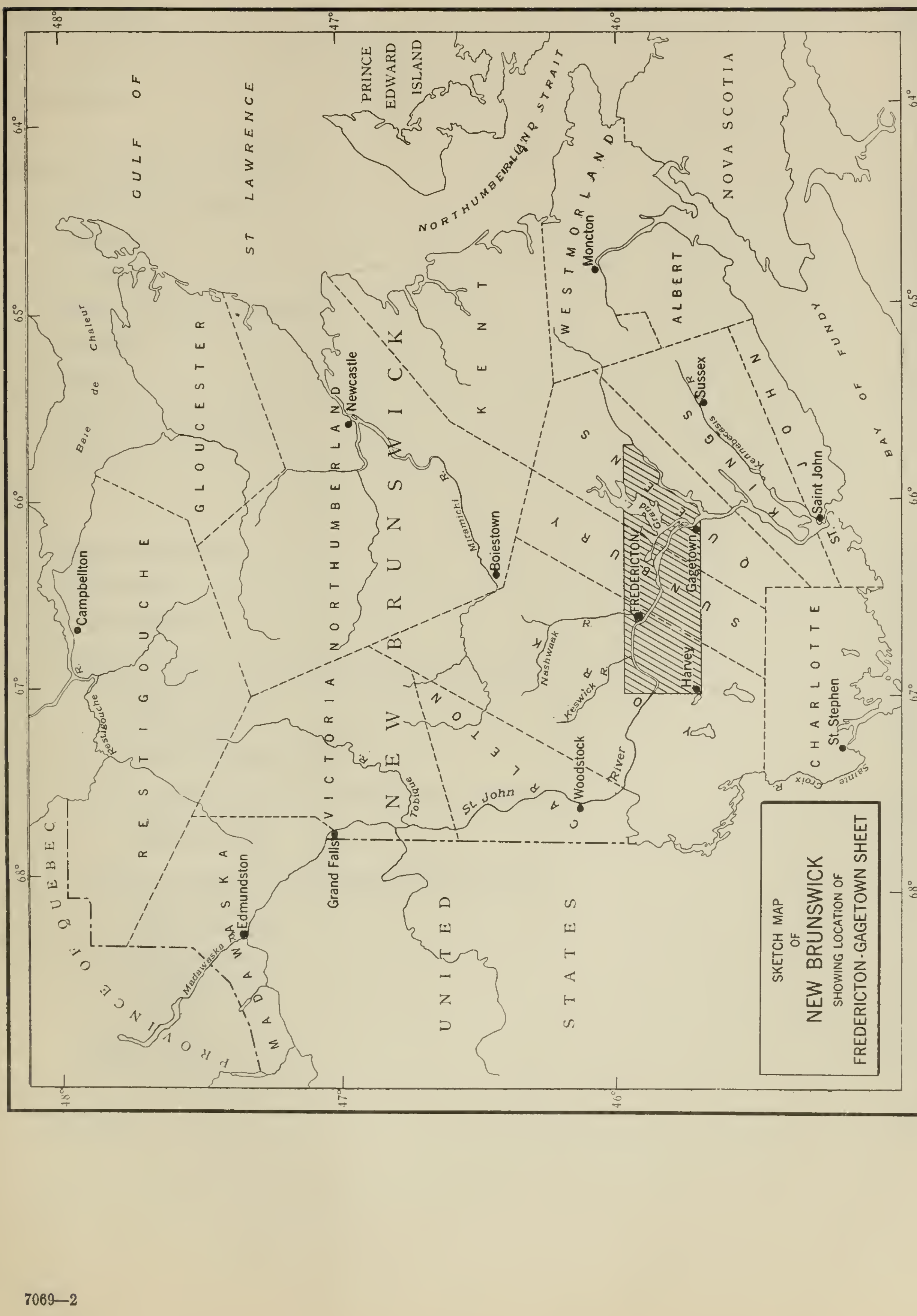

Map published by the Experimental Farms Service, Ottawa

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INTRODUCTION

The New Brunswick Soil Survey is conducted by the Experimental Farms Service, Dominion Department of Agriculture, in co-operation with the New Brunswick Department of Agriculture. It had its beginning in 1938 when field operations were started in the Fredericton-Gagetown area.

The main purpose of the soil survey is to classify and map soils according to their inherent physical and chemical characteristics, to relate the soils, as far as possible, to their agricultural adaptations and possibilities and to determine the main problems associated with the different soil types.

The present report with the accompanying map is the first to be published. The information in this report provides an inventory of the soil conditions in the Fredericton-Gagetown area, the limits of which are shown in the key map on page 4. Every soil type encountered is described in detail. The first part of the description shows the characteristics of the soil by which it may be recognized and the second part describes the relationship between the soil and crop production. The report gives also a brief description of the general area and discusses climatic, topographic and other factors that have a close bearing on the development of the soil and on its value for crop production.

The soil map, which is printed on the scale of one and one-half miles to one inch, is an essential feature of this report. It shows the location and extent of the different soil types, the locations of the various roads, railroads, rivers, towns and most of the farm houses. The densely settled and intensively cultivated districts were surveyed in considerable detail, while the heavily wooded areas were of necessity surveyed in less detail and the individual soil types were not mapped. For these areas, however, the approximate proportions of the different soil types are shown on the map.

The soil survey report provides much useful information to the practical farmer and the scientific investigator. It provides the farmer with a basis for obtaining the best available information on problems of production as related to his own particular soil conditions. It enables the farmer to observe, on land classified the same as his own, what crops grow most successfully and what fertilizer and cultural practices produce the best results.

The soil map serves as a valuable guide to extension men whose duty it is to advise the farmers on problems related to soil productivity and crop production. It is also useful in the planning of experiments in various parts of the province so that important or extensive soil areas may be represented.

Finally the soil survey provides basic information for the development of sound land-utilization policies, as the soils are the natural resources on which the agricultural economy must be based.

SOIL SURVEY OF FREDERICTON-GAGETOWN AREA

By P. C. Stobbe*

GENERAL DESCRIPTION OF THE AREA

Location and Extent

The Fredericton-Gagetown area was surveyed during the summer of 1938. It includes parts of Queens, Sunbury and York counties and covers approximately 1,067 square miles. Of this area 81 square miles are occupied by lakes and rivers, leaving 986 square miles, or 631,000 acres of land.

The surveyed area is bounded on the west by the 67th degree longitude, in the north by the 46th latitude, on the east by the Washademoak River and Washademoak Lake and on the south by a line running from Washademoak Lake to Harvey Station.

The city of Fredericton, the capital of the province, is situated in the north-central part of the area. The St. John River flows through the entire length of the area from west to east, entering at Lower Prince William and leaving at the mouth of the Otnabug River in the southeastern corner of the area.

Topography

The topography of the Fredericton-Gagetown area varies considerably with elevations ranging from 20 to 700 feet above mean sea level.

The St. John River Valley forms a prominent feature of this area. West of Fredericton the valley is quite narrow and the land rises more or less steeply from the river, often attaining an elevation of 200 feet above the level of the river at a distance of 300 feet from the shores. East of Fredericton the land rises more gently from the river and the valley widens out considerably, reaching its widest point near Sheffield, where it is several miles wide. Numerous islands in the St. John and large flats along its shores east of Fredericton have an elevation of 20 to 30 feet above mean sea level and are subject to periodic flooding. The largest of these river flats are found between Maugerville and Sheffield and near Oromocto. West of Fredericton the islands and river flats are smaller in size and not so numerous and their elevation above sea level varies from 30 to 50 feet.

The topography of the upland in the surveyed area varies from undulating to hilly land. East of Fredericton, especially in the vicinity of Grand Lake, the elevation varies from 100 to 250 feet above mean sea level and the topography is undulating to gently rolling, while toward the west and south from Fredericton the topography is more rolling and the elevation generally varies from 200 to 400 feet above mean sea level. In the western section of the area deep water channels and gullies often cut through the otherwise rolling topography, while in the eastern section the water channels are generally not quite so deep and the slopes not so abrupt. In the southwestern corner of the area the land is often quite hilly and too rugged for cultivation. The highest hills in this area are Porcupine and Harvey mountains, both of which have an elevation of 700 feet above mean sea level.

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Drainage

The entire Fredericton-Gagetown area lies in the drainage basin of the St. John River, which flows through the whole length of the surveyed area and receives here a number of tributaries, the most prominent of which are the Keswick, the Nashwaak, the Jemseg, the Washademoak and the Oromocto Rivers. The St. John is also connected with Grand Lake, which is the largest lake in the province, and the largest part of which lies in the northeastern section of the area. Grand Lake in turn is linked with a number of smaller lakes, the largest of which are, Maguapit, French and Indian Lakes. A great number of small streams and creeks empty into these larger bodies of water. After the spring thaws and after heavy rains many of these streams turn into violent and dangerous torrents, carrying with them large quantities of soil; they usually revert to mere trickles of water during the dry summer months.

Local drainage conditions vary greatly throughout the area, depending largely on topographic features. The land in slight depressions and on gently undulating topography is often ill-drained and the water table of the soil on such positions often rises close to the surface. Such ill-drained land is very common in the eastern section of the area where the soil is underlain by a compacted boulder clay which greatly restricts the vertical movement of water in the soil and greatly aggravates drainage conditions. The steeper slopes and hillsides are usually well drained and occasionally over-drained and too dry. However, in some cases the hillsides are springy and wet, a condition brought about by lateral seepage over a compacted subsoil.

Geology and Parent Material

The whole area has been subjected to glaciation and practically all upland soils have been formed on weathered glacial till. Most of the glacial drift and till has been transferred over comparatively short distances, consequently contains mainly boulders and rock fragments which have been derived from the underlying rock. In some places the underlying rock has been exposed by the scraping action of the glaciers, while in other places it has been covered by glacial till to a considerable depth. The parent rock from which most of the drift material in this area has been derived is of the Palaeozoic age.

In the larger part of the area, east of a line running from Harvey to McKinley Ferry and north along the Keswick River, the parent rock consists chiefly of Middle Carboniferous or Pennsylvanian sandstone, shale and conglomerate. These rocks vary from a dirty grey to a reddish-brown colour and often have a greenish tinge. They weather readily when exposed to the air and crumble easily. The Middle Carboniferous rocks contain very few soluble bases and as a result the soils derived from this parent material are very acid and comparatively infertile.

The weathered till on the surface of the soil is usually quite friable and contains numerous rock fragments and occasional boulders. Its colour varies considerably, depending on the amount of organic matter present, on drainage conditions and on the extent of leaching. The soil immediately below the surface layer is generally reddish-brown in colour. In the subsoil, at depths of 2 to 3 feet, the unweathered till of the Middle Carboniferous formation consists chiefly of reddish-brown compact boulder clay and clay loam. Various percentages of gravel and small rock fragments are firmly embedded in the clay.

That section of the surveyed area lying to the west of the above-mentioned line is underlain by rocks of the Pre-Carboniferous formation. The bed-rock consists chiefly of dark coloured shales, schists and gneisses, the strata of which have an incline of 50 to 80 degrees from the horizontal (Fig. 2). The amount of lime and other bases in these rocks varies considerably and usually

the unweathered rock contains enough calcium carbonate to give a slight effervescence when treated with acid. The Pre-Carboniferous rocks weather more slowly than the rocks of the Middle Carboniferous formation, nevertheless, this process is quite noticeable and the lime which is liberated from the weathered rocks has a favourable influence on the soils developed on this formation.

The cover of till over the bed-rock is usually 3 to 5 feet thick, but frequently the depth of the till is less than 3 feet and occasionally bare outcrops of rock are found. The till contains numerous rock fragments which have originated from the underlying rock. The colour of the weathered till near the surface of the soil is considerably darker than that of the till on the Middle Carboniferous formation. The unweathered Pre-Carboniferous till in the subsoil consists of slightly compacted brownish-grey clay loam and clay.

Outcrops of the Lower Carboniferous or Mississippian formation are found along a narrow strip of land between the Middle Carboniferous and Pre-Carboniferous formations. The most pronounced appearances of this formation are found about two miles north of Harvey, at the French Village on the St. John River (Fig. 4) and between Curry Mountain and Keswick on the north shore of the St. John River. Even here the areas occupied by this formation are comparatively small, seldom exceeding one square mile in extent. In most cases the Mississippian formation is covered with a deep layer of drift. The rocks of this formation are usually brick red with layers of greyish to greenish coloured rock. They consist of sandstones, shales, limestones and gypsum. The soils developed on this formation are usually bright red in colour and due to the liberation of lime from the parent material they are not very acid.

On the slopes of the St. John River Valley and its larger tributaries the boulder clay has been covered, during the recession of the glaciers or shortly afterwards, by a layer of sand. This sand has been waterworked and deposited in layers varying in colour and size of particles. The thickness of the sandy layer varies from 1 to 10 feet, the most common depth being 2 to 4 feet.

A number of eskers are found in the St. John River Valley. These consist of gravelly knolls in which the gravel has been deposited in layers of different sized gravel and sand. The layers are not horizontal but slope down toward the sides of the knolls. In this respect the eskers differ from the gravelly outwash at lower elevations. In the latter the layers of gravel and sand are more or less horizontal.

The bottom land in the St. John River Valley consists of recently deposited alluvial material. Thousands of tons of silt are deposited annually during the spring freshets over the surface of the lowlands. As a result definite layers can be observed in the soil due to the periodic depositions and due to texture which is largely controlled by the speed of flow of the water.

Vegetation

Approximately 10·5 per cent of the total land area in the Fredericton-Gagetown district is cleared land, while the remainder is wooded. To the east of the Oromocto River only about 8 per cent of the land is cleared, while west of here about 13 per cent of the total area is cleared land. The bulk of the cleared land is found within close proximity of the St. John River and its tributaries and along the shores of Grand Lake. With the exception of a few comparatively small and isolated settlements along main roads, the interior of the surveyed area is heavily wooded.

It is a well known fact that climate has a marked influence on the type of natural vegetation that dominates a given district. The climate of New Brunswick is associated with forest vegetation rather than with grasses. The

natural tendency for trees to displace the grasses is clearly noticed in many old pasture fields where the trees are encroaching and displacing the pasture vegetation (Fig. 5). Many fields that have been under cultivation for a number of years and have subsequently been abandoned are now covered with a thick stand of trees. It appears that the trees grow much more vigorously on land that has been under cultivation for some time than on undisturbed land. Many young stands of spruce are found on land that was under cultivation 10 to 15 years ago.

The type of vegetation found in a given locality is not only governed by the climate but also by such factors as geological formation, drainage and the soil itself. The history or previous treatment of the forest cover has often also an important bearing on the type of vegetation that is found at present. The natural tree cover may be changed to some extent by the methods of cutting used in the lumbering operations and by forest fires. Most forests in the province of New Brunswick have been burned over from time to time. In many cases the burning has been so severe that it takes a long time for the forest to re-establish itself and often the tree species of the new tree cover differ greatly from those that were present before the fire. Going through a succession of species, it takes often a long time until a tree association has been established that is typical of the natural climatic vegetation.

To show the menace of forest fires in New Brunswick it may be well to quote some figures presented by M. B. Morison in "Forests of New Brunswick," 1938. According to Morison during a ten-year period, from 1927 to 1938, the average annual number of forest fires was 228. During this period on the average 46,000 acres of forest were burned annually with a loss of $95,000. This loss does not take into consideration the damage done to the soil and the unproductive period after the fire, which may be quite long in the case of severe burns.

The most common tree species found in the surveyed area are listed below in their approximate order of prevalence.

Spruce	
White spruce	*Picea glauca*
Red spruce	*Picea rubra*
Black spruce	*Picea mariana*
Balsam fir	*Abies balsamea*
White birch	*Betula papyrifera*
Poplar	
Trembling poplar	*Populus tremuloides*
Deep toothed poplar	*Populus grandidentata*
Balsam poplar	*Populus balsamifera*
Sugar maple	*Acer saccharum*
Beech	*Fagus grandifolia*
Yellow birch	*Betula lutea*
Cedar	*Thuja occidentalis*
Pine	
Jack pine	*Pinus Banksiana*
Red pine	*Pinus resinosa*
Hemlock	*Tsuga canadensis*
Larch	*Larix laricina*

It was found that certain tree species are more prevalent among the natural vegetation on certain soil types than on others. Thus on well-drained soils deciduous trees are more common than on ill-drained soils. The tree cover on the well-drained ridges on the Pre-Carboniferous formation consists almost entirely of the yellow birch, beech and maple association. The well-drained

ridges on the Middle Carboniferous formation have a mixed tree cover with poplar, birch and the beech and maple association dominating over the conifers. On the somewhat heavier soils poplar is often the dominant species. Spruce and fir are also frequently found on the better-drained ridges, however, they are more at home on poorer drained soils and are the dominant species on soils that are intermediate in regard to drainage. On very poorly drained soils, cedar, hemlock, larch and alder are the most prevalent species, although spruce is also present. Most of the swampy peat soils have a cover of stunted black spruce in association with blueberries, Labrador tea, cranberries, leather-wort, etc. Sphagnum moss forms a solid mat on the forest floor of ill-drained soils and in the case of swampy peat soils this layer of moss often reaches one foot in thickness. The white pine and jack pine are as a rule found on the sandier soils. The latter species is seldom found on the Pre-Carboniferous formation.

It was observed that land that has been under cultivation and has subsequently been abandoned often produces solid stands of conifers. This is especially true on the Middle Carboniferous formation. On areas that have been burned severely the new growth depends largely on the supply of seed and the prevalent distribution agencies. Thus on identical soils in burnt-over areas may be found solid stands of spruce, or poplar or some other species, depending on the seed that has been transported into the particular location. It may take several generations until a climax in the succession of tree species is reached and the association typical of the environmental conditions has been established. For this reason it is often misleading if too much emphasis is placed on vegetative cover for the interpretation of soils and soil conditions.

Climate

Owing to the close proximity of the Atlantic Ocean, the climate of the Fredericton-Gagetown area is temperate humid, characteristic of the Maritime Provinces. In this climatic zone the vegetation climax consists of Acadian forests.

Meteorological data compiled from the Dominion Meteorological Records are presented in tables 1 to 4 for four stations in the surveyed area and two stations in adjacent districts. Two stations at Fredericton are located in the central to northern part of the area, the station at Harvey is located in the south-western corner and the station at Gagetown in the eastern section of the area. The station at Chipman is located 12 miles north of the surveyed area, while the station at St. John is located some 40 miles to the south, at the mouth of the St. John River.

TABLE I—MEAN MONTHLY PRECIPITATION RECORDS FOR STATIONS IN AND NEAR THE FREDERICTON-GAGETOWN AREA

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fredericton (Univ. of N.B.) 164*	3·54	2·68	3·12	3·34	3·15	3·54	3·64	3·97	3·78	4·96	3·36	3·51	43·5
Fredericton (Exp. Farm) 106*	3·76	2·74	3·10	3·24	2·85	3·39	3·22	3·59	3·63	4·64	3·11	3·44	40·7
Harvey 490*	3·94	3·01	2·61	2·86	2·99	3·39	3·14	3·39	3·87	5·33	3·42	3·49	41·4
Gagetown 71*	3·97	3·09	3·51	3·10	2·85	3·09	2·87	3·52	3·57	4·13	3·14	3·75	40·7
Average for above four stations	3·80	2·88	3·08	3·13	2·96	3·35	3·22	3·62	3·71	4·76	3·26	3·72	41·5
Outside of area—													
Chipman	3·68	3·23	3·09	3·47	3·26	3·67	3·69	3·38	3·64	3·80	3·31	3·77	42·0
St. John	5·23	3·46	3·93	3·60	3·08	4·02	3·85	3·62	4·65	5·09	3·93	4·42	48·9

NOTE.—All figures are 15-year averages (1924–1939) except in the case of Chipman where only 10-year averages were obtainable.
*Elevation above mean sea level.

The average annual precipitation of the surveyed area, as recorded at the first four stations, is 41·5 inches. This precipitation is fairly uniformly distributed through the different months of the year. During the last 15-year period the lowest average monthly precipitation was received in February and the highest average in October, with means of 2·88 and 4·76 inches, respectively. Occasionally extremely dry summer months occur which cause considerable damage to the crops. An example of such was August, 1939, when less than one inch of rain was received.

The distribution of the precipitation in different parts of the area does not differ very much as is shown in table 1. The greatest difference in the annual precipitation was recorded between the two stations at Fredericton, which are only some three miles apart, the difference being 2·8 inches. At Harvey, which has a considerably higher elevation than the other stations and which is the farthest removed from the St. John River Valley, the mean annual precipitation is approximately equal to the average of the district. Harvey has, however, the driest springs and the wettest falls of any of the recorded stations. Chipman, which is only a short distance off the surveyed area, has an annual precipitation similar to the average of the stations in the district. At St. John the mean annual precipitation is 49 inches, which is 7·5 inches more than in the surveyed area. This increase in precipitation is largely due to the close proximity of the Bay of Fundy and the Atlantic Ocean; the effect of the sea, however, does not extend very far inland.

The monthly temperature records at the different stations in the surveyed area are presented in table 2.

TABLE 2.—MEAN MONTHLY TEMPERATURE RECORDS FOR STATIONS IN AND NEAR THE FREDERICTON-GAGETOWN AREA

Stations	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fredericton (Univ. of N.B.)	14·3	14·8	25·8	39·0	50·5	60·8	66·3	64·7	56·3	45·5	33·2	19·3	40·9
Fredericton (Exp. Farm)	15·0	15·6	26·4	39·2	51·0	61·1	66·4	64·9	56·6	45·6	33·6	19·7	41·3
Harvey	14·1	14·9	25·0	37·9	50·2	60·5	65·7	64·5	55·9	45·3	32·9	18·7	40·5
Gagetown	17·2	17·1	27·7	39·6	51·4	61·4	66·9	65·7	56·8	46·9	34·8	21·4	42·2
Average for above four stations	15·2	15·6	26·2	38·9	50·8	60·9	66·3	64·9	56·4	45·8	33·6	19·8	41·2
Outside of area—													
Chipman	13·0	12·4	24·3	38·4	50·2	61·2	66·2	64·8	56·2	44·8	32·0	17·5	40·0
St. John	20·3	20·3	29·1	39·0	48·5	57·1	61·6	62·7	56·5	47·7	36·4	24·3	42·0

NOTE.—All figures are 15-year averages (1924–1939) except in the case of Chipman, where only 10-year averages were obtainable.

The mean annual temperature in the Fredericton-Gagetown area is 41° F., and considerable seasonal variations can be noticed in table 2. Although the mean temperature for January is 15° F., extreme lows of –43° F. have been recorded during the last 15-year period. July, the hottest month of the year, has an average of 66° F., with a maximum of 101° F. The temperature variations in different parts of the surveyed area are not very great. Harvey has the lowest mean annual temperature of 40·5° F., and Gagetown has the highest mean annual temperature of 42·2 degrees. This difference is almost entirely due to more extreme cold temperatures in Harvey during the winter months which may be related to position and elevation. Harvey has an elevation of 490 feet above mean sea level and no large bodies of water are found in its close proximity, whereas Gagetown has an elevation of 71 feet above mean sea level and is located in the St. John River Valley close to Grand Lake and Washademoak Lake. At Chipman, which is just to the north of the surveyed area, the annual mean temperature is 40° F. From table 2 it is seen that the summer temperatures are just as high at Chipman as at Gagetown, but the winter temperatures are considerably lower than at any of the other

stations listed. At St. John the mean annual temperature is approximately the same as that at Gagetown. The data in table 2, however, reveal that the close proximity of the sea affects the temperature appreciably. The mean winter temperatures are at least 3 degrees higher and the summer temperatures 4 degrees lower at St. John than at Gagetown.

The average length of the frost-free period in the surveyed area is 140 days, as shown in table 4. Harvey has the shortest frost-free period and

TABLE 3.—MEAN MONTHLY HOURS OF SUNSHINE AT FREDERICTON AND SAINT JOHN, 1924-1939

Stations	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fredericton (Exp. Farm).......	106·8	119·1	143·1	170·7	209·9	211·3	229·2	219·9	153·1	136·9	100·5	89·8	1890
Saint John.....................	111·3	119·4	153·3	169·1	207·7	204·4	223·9	214·3	163·1	140·7	104·8	99·0	1911

TABLE 4.—DATES OF LATEST AND EARLIEST FROST AND THE AVERAGE LENGTH OF FROST-FREE PERIOD 1924-1939

Stations	Latest frost recorded	Earliest frost recorded	Average dates of		Average length of frost-free period
			Latest frost	Earliest frost	
Fredericton (U. N.B.)......	May 23, 1932	Sept. 21, 1929	May 18	Oct. 6	141 days
Fredericton (Exp. Farm)....	June 3, 1927	Sept. 23, 1929	May 15	Oct. 1	139 days
Harvey......................	June 2, 1927	Sept. 21, 1929	May 16	Sept. 29	136 days.
Gagetown....................	May 24, 1927	Sept. 13, 1935	May 10	Oct. 2	145 days
					Av. 140 days
Chipman.....................	June 22, 1931	Sept. 4, 1935	May 31	Sept. 14	106 days
Saint John..................	May 16, 1936	Oct. 9, 1929	April 29	Oct. 21	175 days

Gagetown the longest, the difference being 9 days. At Chipman, which is just a short distance off the map, the average length of the frost-free period is almost a month and a half shorter than at Gagetown, whereas at St. John it is a month longer than at Gagetown.

Comparing the hours of sunshine at St. John and at Fredericton it is seen in table 3 that the total number of hours, 1911 and 1890, respectively, is almost the same in both places. St. John receives more sunshine during the winter and fall months, whereas Fredericton receives more sunshine during the summer. While there are quite a few completely cloudy days at Fredericton, St. John has a considerable amount of fog, especially during the summer. The fog can be seen to extend up the St. John River Valley as far as Cambridge on the Washademoak Lake.

The data presented indicate that the climate in the eastern section of the area, especially along the St. John River Valley, is somewhat more temperate than in the western section of the area. This is largely due to the closer proximity to the Bay of Fundy and the Atlantic Ocean.

History and Development

The earliest white settlers in this district were the French Acadians. They settled early in the 18th century (1718) on the shores of the St. John at Maugerville and built the village of Ste. Anne on the site of the present city of Fredericton. At the beginning of the second half of the same century English settlers from Massachusetts came to this district and tried to displace the Acadians. Later, in 1783, a group of Loyalists from the newly created United States selected this region as the most favourable locality for settlement and

evicted the Acadians. After 1800 some thousands of people from the British Isles took up land in this section of the province. The present population consists largely of descendants of the Loyalists and the early English settlers and of some of the Acadian stock that returned in later years.

The total population of the area is approximately 25,000. Most of the settlements are found along the St. John River and its tributaries and along the shores of Grand Lake and Washademoak Lake. Fredericton, the capital of the province, with a population of approximately 9,000, is situated on the St. John River opposite the mouth of the Nashwaak. Some of the other principal towns and centres of population are Gagetown, the county seat of Queens County, Oromocto, Devon and Keswick, all on the St. John River and Marysville on the Nashwaak. Harvey, in the southwest corner of the area, is the only village of any size that is located on the upland.

The settlements are fairly well served by railways and roads. Fredericton is linked with the main Canadian Pacific Railway line by a branch line from Fredericton Junction and a second line links Fredericton with Minto, Chipman and Moncton. A Canadian National Railway line joins Fredericton with Newcastle and the north shore, while a second line runs along the shores of the St. John. During the summer months regular boat service is maintained between Fredericton and St. John with numerous points of call along the St. John River, Grand Lake and Washademoak Lake. The principal roads along the St. John River serving most of the larger centres are surfaced and in good condition, but the side roads are, as a rule, not in very good shape. The train and boat services and the good condition of the main roads play an important factor in the transportation and marketing of the agricultural commodities produced in this district.

Agriculture and lumbering are the largest industries in the province and a large percentage of the population obtain a considerable share of their income from work in the bush during the winter months. About 20 per cent of the forested land in this area is held by the Crown, while the remainder is privately owned. Many portable lumber mills can be found in different sections of the area. In addition, larger permanent mills are located at Fredericton, Oromocto, Gagetown and Ripples. A considerable amount of the wood is cut for pulp and shipped to the mills at St. John or for export. Manufacturing in this area is limited to the cotton mill at Marysville, which employs several hundred men the year round, and several shoe factories at Fredericton. Fredericton itself is mainly a government and university town, as most of the provincial government offices and the University of New Brunswick are located there.

Agriculture

The first agricultural development in this area began in the early part of the 18th century when the French Acadians settled here. At that time they obtained their livelihood from fishing, fur trapping, lumbering and farming. Of necessity farming practices were very primitive in those days. Although great advances have been made since that time in the general farm practices and in the use of fertilizers in particular, even yet most of the well-to-do farmers practise lumbering and fur raising in connection with the production of agricultural crops.

The average farm in the area consists of 100 to 200 acres of land and the more recent grants of land for colonization purposes consist of 100-acre lots. At the same time the average area of land under cultivation is 35·9 acres per farm plus 11·6 acres of rough pasture, the remainder being wooded. The large size of the farm woodlots gives a good indication of the close relationship between lumbering and agriculture. The revenue obtained from the forest during the winter months is of great help to the farmers and the returns to many farmers

would be rather meagre if it were not for this source of income. On some farms lumbering is the main source of revenue and the farm serves as a side-line to raise a few vegetables and to provide enough pasture and hay for a cow or two. In recent years the slump in the pulp and lumber industry has caused great hardships for such farmers. Although the work in the woods during the winter months is desirable and of great help to the farmer, the lumbering operations will become a drawback if they keep the farmer from the fields when he should be planting, cultivating or harvesting. It is difficult for an individual to be both a good lumberman and a good farmer, nevertheless, there are many farmers in the surveyed area who profitably combine farming and lumbering. Many farmers claim that the best set-up is one in which the farm has 100 acres of woodland and 50 to 60 acres of cultivated land. From the standpoint of proper land utilization such a scheme is perhaps the most sound as some of the land can only be classed as marginal or submarginal agricultural land, yet it will produce good crops of forest and lumber.

The comparatively small percentage of cultivated land in relation to woodland on the farms is to some extent due to the layout of the farms. The farms are laid out in long narrow strips, 200 to 400 yards wide, facing the river or main road in front and running often as far as 3 and 4 miles back into the interior. Such narrow strips are hard to farm, as the back end of the farm is too far removed from the buildings and, therefore, it invariably remains in woods. At comparatively short distances from the rivers, ridges very often cross the farms cutting off the free surface drainage. Strips of poorly drained land, varying in width, and unsuitable for agricultural purposes, are usually found behind these ridges. Such ill-drained land is usually difficult to drain, as it usually extends across a number of farms, and the installation of a proper drainage system requires the combined effort of several farmers. Many acres of such ill-drained land have been cleared and brought under cultivation but, due to its unsuitability, it frequently reverts back to bush. In many cases good agricultural land is found behind the strips of ill-drained and swampy land but it is difficult of access from the cultivated section of the farm. Thus it often remains in bush and the cultivated land is usually confined to a small acreage near the front of the farm. Under conditions where the area of cleared and cultivated land is too small to provide a livelihood for the farmer he is still able to make a living as long as the supply of pulp and lumber holds out at the back of his farm. However, as soon as this source of income has become depleted by too vigorous cutting and poor management, the financial condition of the farmer becomes so poor that he is often forced to leave his land and find a livelihood elsewhere. It is, therefore, imperative that considerable thought and care should be exercised in the management of these large woodlots, so that they will supply a continuous income to the small land holder.

The total area of cultivated land has not very markedly increased during the last 20 to 30 years and in some localities, due to the abandoning of many farms in recent years, the area of land under cultivation has been decreased. The reasons for the halt in the expansion of cultivated land on the one hand, and the abandoning of farms on the other, are among the following: unsuitability of the soil for agricultural purposes, the lack of agricultural markets, poor means of transportation and communication and lack of social organizations such as schools and churches in the isolated inland settlements, poor layout of the land for farming purposes and the lack of industry and initiative on the part of the farmers. There are many abandoned farms in the surveyed area and in some cases repeated attempts have been made to put settlers back on these farms with varying degrees of success. The reasons for failure, as pointed out above, are variable and a careful study of each failure should be made before resettlement is attempted. In cases where failure is largely due to unfavourable soil conditions, which may or may not be associated with the layout of the land, resettlement is a waste of effort. If failure is due to poor management of the

farm land and lack of aggressiveness on the part of the individual, resettlement will, in all probability succeed, provided the right type of settler is given an opportunity. In isolated areas social services such as schools, churches and means of communications can only improve appreciably if the number of settlers is increased. In any resettlement scheme the choice of the individual settler is a very important factor to consider.

Soil surveys of abandoned farms should offer valuable information regarding the suitability of the soil for agricultural purposes. They should in many instances save considerable money and avoid unpleasant hardships in preventing the resettlement of unsuitable farms.

The most prevalent type of farming in the surveyed area is mixed farming. As seen from tables 5 and 6, oats, hay and pasture occupy by far the largest percentage of the cultivated land. The yields of these crops vary considerably according to the fertility of the soil. The average yields for 1930 are very low as seen in table 6. In this regard it may be pointed out that 1930 was a better crop year than the average. Most of the soils are very acid and an application of lime is a prerequisite before a good clover crop can be grown. Under good farm practices, with the proper use of fertilizers and lime, hay crops of 2 to 3 tons per acre and oat yields of 50 bushels to the acre can easily be obtained.

TABLE 5.—DISPOSITION OF LAND IN THE FREDERICTON-GAGETOWN AREA

	Acres
Total area of land	646,400
Area of occupied land	243,000
Unimproved land	192,700
Woodland and marsh	176,600
Unimproved pasture	16,200
Improved land	50,300
Pasture	11,000
All crops (cultivated)	39,300
Total number of farms	1,400
Average size of farm	173·5
Average area of improved land per farm	35·9
Average area of unimproved pasture per farm	11·6

TABLE 6—ACREAGE UNDER DIFFERENT CROPS AND AVERAGE YIELDS IN 1930 IN THE FREDERICTON-GAGETOWN AREA

	Acres	Yield per acre
Wheat	40	19·0 bushels
Barley	125	26·5 "
Oats	5,500	27·5 "
Buckwheat	1,200	22·0 "
Hay	27,000	0·9 tons
Potatoes	2,100	192·0 bushels
Roots	800	
Orchards	1,860	
Gardens	215	
Other crops	460	
	39,300	

Wheat and barley are not grown to any extent, although the soil is fairly well suited for the latter crop and an increased barley acreage should fit in very well with the type of farming practised in the area. Buckwheat is grown partly for feed and partly as a cash crop. Small acreages of potatoes are grown on most of the farms as cash crops. The 1930 yield of 192 bushels per acre is considerably higher than that of the average yield. The production of potatoes in this area can not be compared with the commercial potato growing in Carlton and Victoria counties where the soil is more suited for this crop.

Most apple orchards in New Brunswick are grown in the St. John River Valley. The largest apple growing centres in the surveyed area, where apples are the main source of revenue, are at Burton, Gagetown, Kingsclear, Douglas and

Keswick Ridge. In these areas the soil is, as a rule, more suited for apple trees than in the remainder of the district, although, there are isolated areas where the soil is well adapted to this crop.

In 1930 more than one quarter of the strawberries of the province were produced in the surveyed area. During recent years with the organization of the Grand Lake Strawberry Association the interest in this crop has been greatly stimulated. As a result, the area devoted to strawberries has been greatly increased and many thousands of crates of fruit are produced annually for the home and export markets. This crop is mainly grown on the shores of Grand Lake and Washademoak Lake where the soils and climatic conditions are especially favourable for strawberry production.

In the Sheffield-Maugerville district, the low lying Interval Soils are well suited for market gardening. Such crops as cucumber, cabbage, cauliflower, corn, beet, onion, etc., form an important source of revenue. The acreage of land devoted to these crops is chiefly determined by the available markets.

During recent years attention has also been paid to the production of cranberries on the muck soils in the vicinity of Rusagonis.

SOILS

Soil Survey Methods

The soil survey conducted in the Fredericton-Gagetown area may be classed as a detailed-reconnaissance and reconnaissance type of survey. The detailed-reconnaissance survey was conducted in the more densely settled areas along the river valleys where the soil was examined in considerable detail and occurrences in soil variation to about five acres in extent were mapped out. In these sections foot traverses were made at 400- to 800-yard intervals, depending on the uniformity of the land. The soil boundaries were drawn in accordance with the lay of the land between points of inspection. In the sparsely settled and heavily wooded sections of the interior, where roads are scarce, traverses were made along the roads and trails at one- to two-mile intervals, depending on the opportunities offered. The main object of this reconnaissance survey in the heavily wooded section of the area was to see if any large areas of soil suitable for colonization purposes could be found. No attempt was therefore made to locate the boundaries between the individual soil types and phases and the soils were mapped as complexes. The separation of individual soil types in wooded areas is a very time-consuming operation and the extra information that could be obtained by a more detailed survey did not warrant the extra time and expense involved.

The traverses along the roads were made in cars, using the speedometer for measuring distances and locating the points of examination of the soil. In the foot traverses distances were measured by pacing and the directions were recorded by the use of a compass. In the surveyed area the individual farms are long, narrow strips of land facing the river or some road. The roads are located irregularly, in some cases two or three roads may be close together while in other cases they may be separated by several miles of wooded country. This type of layout makes it difficult to survey and to run traverses at definite intervals.

A reliable base map is very important in soil survey work. For the greater part of the area maps published by the Department of National Defence and by the Topographical Surveys of Canada on the scale of one inch to one mile were used as base maps for the soil survey and proved very satisfactory. For a small section in the northeastern corner of the area no satisfactory map was available, and a base map showing all the roads, railroads, the approximate location of the larger rivers and streams and the farm houses, was prepared by the soil surveyors.

The soil was mapped and described according to its profile characteristics, as the profile is the end result of the interaction of the different soil forming agencies. All soil examinations were made by the use of spade or shovel and in some cases picks and crowbars had to be resorted to in exposing the soil profiles. Soil augers could not be used to any extent because of the stony nature of the land. External features, such as stoniness and roughness of topography, were also taken into account in differentiating the soils. The actual degrees of slope were not marked on the map but the frequent contour lines on the map give a good indication of the nature of the topography in the various sections of the area.

Representative soil samples were collected for physical and chemical analysis at the time of survey. Typical soil profiles of each soil type under undisturbed conditions in the woods were selected for sampling wherever possible. Each horizon of the soil profile was sampled by taking a thin slice from the whole thickness of the layer. In addition a composite sample of surface soil was taken from adjacent cultivated fields whose past history is known and which have not received any commercial fertilizer treatments during the last three years or more.

Soil textures were determined by the Bouyoucos method following the procedures outlined in Soil Science, Vol. 38, 1934. The pH was determined by the quinhydrone electrode and standard A.O.A.C. methods of analysis were used for the determination of total constituents. In addition rapid tests for phosphorus, potassium, calcium and magnesium were made by the Morgan Spot Test for comparison.

Soil Formation

Soils are the products of environmental conditions under which they have developed. The soil development and the processes that are involved in this development are largely controlled by a number of factors. The most important of these factors are, the climatic and biological forces that have acted on the soil, the nature and mode of deposition of the mineral parent material from which the soil has formed, the age of the soil or the length of time during which the the above forces have been at work, the topography of the land surface and the drainage of the soil. The effect of the above factors on the soil may be modified by the work of man.

The biological forces, including the nature of the vegetation, the microbiological life in the soil and the rate and nature of decomposition of the organic matter, under normal conditions depend very largely on climatic conditions. Similar climatic conditions often extend over large areas or zones which correspond to soil zones in which the soil under normal conditions reflects the influences of the active soil forming forces, climate and vegetation.

The climatic conditions prevalent in New Brunswick favour the development of acid leached soils, known as podsols. In the podsol zone under normal conditions the climate favours a coniferous tree cover and the accumulation of organic matter on the surface of the soil. During the slow process of decomposition of the organic matter various organic acids are formed together with a variety of other decomposition products. The organic acids and the large amount of percolating water cause considerable leaching. By the leaching process most of the soluble bases such as calcium, magnesium, sodium and potassium and the sesquioxides, such as iron and aluminium, are removed from the surface soil leaving a grey layer, high in silica near the surface immediately below the layer of organic matter. The sesquioxides are accumulated below the grey layer giving the new horizon a characteristic reddish-brown colour and often causing unfavourable physical conditions by cementing the soil into an impervious layer. The common characteristics of the typical well-developed podsol soils in New Brunswick may be summarized as follows: they are distinctly acid, the organic matter has mainly accumulated on the surface and is not distributed throughout the upper layers of soil; under the organic matter is a grey layer, varying from 1 to 10 inches in thickness which is in turn underlain by a somewhat compacted reddish-brown layer.

Most of the soils in the Fredericton-Gagetown area show some degree of podsolization due to the influence of the prevalent climatic conditions, yet there is a great variation in soil types. Some of the variations are very abrupt and marked, while others are very gradual and hardly noticeable. These variations are not directly due to climate but to some other factors which to some extent may be associated with climate, although not necessarily so.

Although the nature of the natural vegetation is generally closely associated with climatic conditions, local factors such as the parent material and drainage of the soil often cause great variations in vegetative cover. It has been pointed out earlier that the type of tree cover in the Fredericton-Gagetown area varies considerably, depending largely on these two factors. The rate and decomposition of the organic matter and the kind of end products that are produced, depend to a large extent on the nature of the plant remains and consequently on the plant species grown on the soil. The foliage from deciduous trees decomposes much

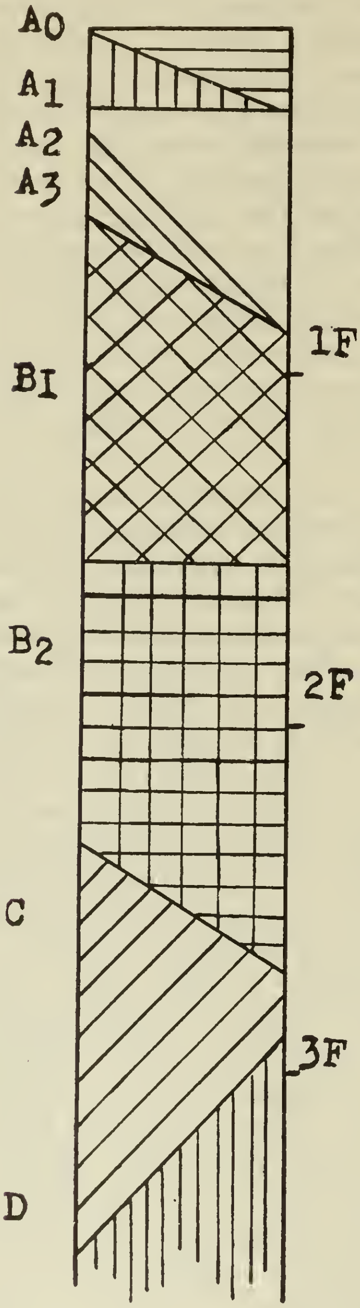
more readily than that of conifers and the products of decomposition of the deciduous foliage cause less leaching and form a more productive soil. The organic matter produced from the foliage of different species of deciduous trees also varies considerably in its effect on the soil. In the surveyed area the sugar maple, beach and yellow birch association is usually found on less leached and more fertile soils than white birch and poplar, while the conifers are invariably found on poorer and more severely podsolized soils.

Under local conditions the development of the soil may be greatly affected by the nature of its parent material. The texture and the mode of deposition of the parent material and the chemical composition and ease of weathering of the mineral fragments contained in the parent material, all have an important bearing on the soil and determine the resistance of the soil to leaching and its degree of podsolization. If the mineral parent material weathers easily and liberates lime or other bases during the weathering process, these bases will tend to neutralize the organic acids and thus restrict the leaching process. On the other hand, if the weathering products are neutral or acid in reaction, the leaching process will be accelerated. The texture, physical condition and mode of deposition of the parent material may greatly affect soil development due to restriction of water movements. Open, sandy soils which permit free percolation are usually severely podsolized in the surveyed area, while the heavy-textured soils are only slightly podsolized, due to the restriction of the downward movement of water.

Drainage is another important factor that affects the development of the soil. Drainage conditions are closely associated with the soil climate, i.e. the temperature and moisture relationships in the soil which are important factors in controlling the microbiological activity in the soil. The soil climate and drainage may vary greatly in a locality where differences in atmospheric climate are negligible and they depend to a large extent on relief, or in other words, the position of the soil in relation to topographic features. On slopes, varying percentages of the precipitation do not penetrate the soil but are lost by run-off. The relative amount of run-off depends on the degree of slope, the texture, the moisture-holding capacity of the soil, the vegetative cover and the rate at which the precipitation falls. Where the percentage of run-off is great the soil is formed under conditions which are typical of more arid regions. On flat lower-lying positions the soils are formed under conditions which are typical of more humid climates because the soil is exposed to all of the falling precipitation plus a certain amount of run-off. If the water-holding capacity of the soil is not large enough to absorb all the precipitation the soil becomes water-logged. This water-logged condition has a great effect on the temperature and aeration of the soil. The microbiological activity in such ill-drained soils is greatly restricted and the organic matter tends to accumulate. These conditions have a great effect on the type of vegetation that may be found in a given position and also, indirectly, on the nature of the organic matter that is contributed to the soil. It is thus seen that soil climate, drainage and relief are all closely related features which may cause great soil variations in a locality where the atmospheric climate and geological conditions are identical. In the surveyed area, where topographic features change frequently, great differences in the pedological characteristics and agronomic possibilities of the soils are encountered. Soils varying from good to submarginal agricultural land, due to drainage conditions, can often be found in small fields. In some cases the typical soil characteristics of the climatic region may be completely masked by the action of local factors. Such soils have been classified in various parts of the world as intrazonal soils.

The age of the soil, or the length of time that a given soil has been under the influence of the various soil-forming factors determines to a large extent the maturity of the soil or, in other words, the extent to which the soil-forming

processes have affected the soil. Soil materials of recent deposition, such as the lowland soils in the St. John River Valley, have not been in position long enough to develop the normal soil characteristics of the region and the typical soil horizons are absent. Such soils are frequently referred to as azonal soils. The geological material of the upland soils in New Brunswick has been in position for a sufficient length of time for the regional soil forming processes to become manifested.



A_0 Forest litter, largely undecomposed.

A_1 Well decomposed black humus.

A_2 Ash-grey leached horizon.

A_3 Greyish-brown transitional layer, often absent.

B_1 Reddish-brown layer.

B_2 Brown layer slightly compacted.

C Parent material from which soil profile has developed.

D Underlying stratum unrelated to parent material of soil profile.

Fig. 1.—Hypothetical profile of a normal well-drained soil in the Fredericton-Gagetown area.

The influence of the discussed factors during the process of soil formation results in the establishment of definite soil characteristics which are expressed in the cross-section of the affected portion of the soil known as the soil profile. The upper portion of the soil profile, known as the "A" horizon, is the zone of maximum weathering, and the maximum removal of the products of weathering. Below the "A" horizon is the "B" horizon, which is the zone of maximum concentration of the products of weathering, which have moved downward

from the "A" horizon. Underlying the "B" horizon is the "C" horizon, which may be only slightly altered by the soil-forming processes. The main soil horizons may be sub-divided into A_1, A_2, A_3, B_1, B_2, etc., for more accurate descriptions.

The organic matter that is added to the surface of the soil in the form of a leaf mat or forest litter is designated as "A"$_0$. In poorly drained soils the horizon developed under the influence of groundwater is referred to as the "glei" horizon and is designated by the symbol "G." If the soil is underlain by geological material that differs distinctly from the parent material of the soil, and which affects the overlying soil in any way, such material is designated as the "D" horizon.

An illustration of a hypothetical profile of a typical well-drained upland soil in the Fredericton-Gagetown area is given in figure 1. Under field conditions the depths of the different horizons vary considerably with the different soil types and in some instances some of the sub-horizons are absent.

Soil Classification

A satisfactory system of soil classification must take into consideration the various factors that guide the process of soil formation and the various soil characteristics which are the result of the action of any one or the interaction of several of the above discussed factors. In the Fredericton-Gagetown area the soils were classified according to the following scheme which takes into consideration the climatic and vegetative features, the nature and mode of deposition of the mineral parent material, drainage and topography, texture and other pedological features.

SCHEME OF SOIL CLASSIFICATION USED IN THE FREDERICTON-GAGETOWN AREA

Zone—Podsol.

A. Soils on Glacial Till Derived from Sandstones and Conglomerates of the Middle Carboniferous (Pennsylvanian) formation
- (*a*) Well-drained soils.
  - I. Queens series.
    1. Queens loam
    2. Queens sandy loam.
    3. Queens clay loam.
- (*b*) Ill-drained soils.
  - I. Kings series.
    1. Kings loam.
    2. Kings sandy loam.
    3. Kings sandy clay loam.
  - II. Cambridge series.
    1. Cambridge loam.
    2. Cambridge sandy loam.
    3. Cambridge clay loam.

B. Soils on Glacial Till derived from Shales, Slates and Sandstones of the Pre-Carboniferous Formation.
- (*a*) Well-drained soils.
  - I. Carleton series.
    1. Carleton loam.
    2. Carleton sandy loam.
    3. Carleton clay loam.
- (*b*) Ill-drained soils
  - I. Washburn series.
    1. Washburn loam.
    2. Washburn clay loam.
    3. Washburn clay.

C. Soils on Stratified Water-worked Parent Materials along River Channels and Valleys.
- C_1 Soils on Gravelly Outwash, Kames and Eskers.
  - (*a*) Well-drained soils.
    - I. Gagetown series.
      1. Gagetown gravelly loam.
      2. Gagetown sandy gravelly loam.
      3. Gagetown shaley loam.
      4. Gagetown gravelly loam, hardpan phase.

SCHEME OF SOIL CLASSIFICATION USED IN THE FREDERICTON-GAGETOWN AREA—*Concluded*

C_2 Soils on Sandy Parent Material on Slopes and Level Low Land.
- (*a*) Well-drained soils.
  - I. Riverbank series.
    1. Riverbank sandy loam.
    2. Riverbank loamy sand.
    3. Riverbank sandy gravelly loam.
    4. Riverbank sandy loam, silty phase.
- (*b*) Ill-drained soils
  - I. Oromocto series.
    1. Oromocto sandy loam.
    2. Oromocto sandy silty loam.

C_3 Immature Soils on Bottom Land Subjected to Periodic Flooding.
- (*a*) Well-drained soils.
  - I. Interval series.
    1. Interval silty loam.
    2. Interval sandy silty loam.
    3. Interval silty clay loam.
  - II. Rusagonis series.
    1. Rusagonis sandy clay loam.
    2. Rusagonis clay loam.
- (*b*) Ill-drained soils
  - Ill-drained phases of the Interval and Rusagonis series.

D. Organic Soils.
- (*a*) Peat.
- (*b*) Muck.

E. Rough and stony land.

The entire Fredericton-Gagetown area is situated in the podsol zone and, unless local conditions interfere with the normal development of the soil, the profiles display signs of podsolization.

The profile examinations proved that all the soils formed from similar parent materials have certain characteristics in common and differ in some respects from the soils on other kinds of parent materials. Thus the soils on the Pennsylvanian formation are more distinctly podsolized than the soils on the Pre-Carboniferous formation, due to the lack of lime in the former. The soils on the Pennsylvanian formation also have very compacted boulder clay subsoils, while the subsoils on the Pre-Carboniferous formation are not nearly so compacted. The soils on the waterworked parent materials differ considerably from the upland soils, due to the mode of deposition and the origin of the parent material. Soils found on corresponding positions on the different parent materials usually have certain characteristics in common. Thus the Queens Loam on the Pennsylvanian formation and the Carleton Loam on the Pre-Carboniferous formation are found on similar positions and have certain characteristics in common. Both differ in similar respects from the Kings and Washburn series in corresponding ill-drained positions.

Several soil series may be found on the same parent material. The term "series" has been adopted to designate a group of soils on uniform parent material with similar profiles, by appearance and in pedological characteristics. The greatest differences in soil profiles on similar parent material in the surveyed area are due to position and drainage and thus the series are closely linked with drainage. The different series have been given names for convenient usage and in order to avoid lengthy descriptions. A descriptive name that would give some indication about the nature and properties of the soil would be most desirable. However, since such names are difficult to coin for all the series, geographical place names had to be resorted to in most cases. Names of a town, city, county or river, near or in which the soil was first described, were given to the soil series.

As mentioned above, the profile of a soil series varies but little. Small differences due to variations in texture of the surface soil are frequently encountered and these are known as soil types. These textural variations are

of great importance from an agricultural standpoint. It should, however, be pointed out that the textural variations in any one series cannot be very great. Large differences in texture cause greater differences in the soil profile and the productivity of the soil than is permitted in a series. The soil types retain the series name to which the textural class name is added, thus, Queens series; Queens Loam, Queens Sandy Loam, etc.

Variations within the soil types that are of importance from an agricultural point of view are known as phases. The phases are based on such characters as stoniness, topographic features, depth of horizons, small differences in drainage, etc.

Discussion of Soils

Soils on Glacial Till of the Middle Carboniferous Pennsylvanian Formation

The Pennsylvanian or Middle Carboniferous formation covers approximately 62 per cent of the surveyed area. Due to the parent material all the soils on this formation have certain things in common. They all have a reddish-brown compacted subsoil consisting of boulder clay to clay loam with small stone fragments and gravel solidly embedded in the clay. This compacted subsoil greatly restricts the free movement of the groundwater. As the dominant rock fragments are sandstone and conglomerate no lime is liberated on the weathering of the parent material. As a result all the soils on this formation are quite acid, varying from pH 4·0 to 4·5, and podsolized.

The following series have been mapped on the Pennsylvanian formation; the Queens series, the Kings series and the Cambridge series. These series are always found in association with each other and often alternate from one to another in comparatively short distances, depending on topographic positions and drainage. Although these series are very closely associated, the differences between the individual series are very marked and important from an agricultural viewpoint.

THE QUEENS SERIES

The Queens series comprises the most important agricultural soils on the Pennsylvanian formation. They are found scattered in the eastern and central part of the area on well-drained positions on the slopes and crests of hills. The topography of this soil series varies from undulating to hilly, but since the variations are so frequent, it was not possible to map all the topographic phases on the adopted scale of mapping. The general topography over the larger part of the area may be described as moderately rolling, while in the north-eastern corner of the map between Grand Lake and Washademoak River the topography is somewhat smoother and is generally gently rolling. On the steeper slopes erosion is often rather severe, especially on fields that have been farmed for a considerable period and where special practices to check erosion have not been used. Where most of the surface soil has been lost by sheet erosion, the soil is reddish-brown in colour, lacks organic matter and has a very shallow profile. Where such eroded areas are extensive enough to indicate on the map the soil has been mapped as the shallow phase of the Queens series.

Stones are frequently encountered in the Queen series and they vary in size from hen's eggs to large boulders, several feet in diameter. They consist chiefly of sandstones, varying in colour from greyish-green and grey to reddish-brown. The surface of the exposed stones and boulders weathers easily and is quite crumbly and soft. Slabs of boulders and fragments of rocks are often torn loose by the plough and crumble up. Stone fences are frequently found along the edges of fields. In cases where the stones and boulders are so numerous as to make ordinary cultivation difficult, the soil was mapped as the stony phase of this series (Fig. 7).

Under cultivated conditions the surface layer of the Queens series extending to plough depth consists of light chocolate brown loamy soil. The colour varies to some extent with the cultural practices that have been used. If organic matter has been depleted by continuous cropping, the colour of the surface layer takes on a distinctly reddish tinge. The soil is loose and friable and is finely granular to structureless. The reaction of this soil varies from a pH of 4·5 to 5·5. The immediate subsoil is, as a rule, bright reddish-brown to orange-brown in colour, very loose, friable and structureless. Occasionally a thin layer of light grey to white soil is found between these two layers. At approximately 24 inches the soil is underlain by very compact dark reddish-brown boulder clay to clay loam, cloddy to massive in structure. This compacted layer greatly restricts the free movement of groundwater and often causes lateral seepage.

Three types of soil have been mapped in the Queens series, namely, loam, sandy loam and clay loam. The loam is by far the most common type of the series and a detailed description of its profile as found under natural conditions is given below.

Horizon	Depth	Description
A_0	0 –1″	Partly decomposed litter, consisting chiefly of coniferous foliage and some leaves of deciduous trees. Numerous small rootlets are interwoven throughout the leafmat. The reaction varies from pH 3·8 to 4·2.
A_1	1 –1½″	Dark brown to black friable loam, containing a considerable amount of well decomposed organic matter, and interwoven with numerous roots. This layer is often absent while in some cases it is 2″ thick. pH 3·8 to 4·2.
A_2	1½–4½″	Light grey to white very friable silty loam with slightly developed platy structures. The thickness of this layer varies from 1½ inches to pockets 6 to 8 inches deep. Numerous roots are found throughout the layer; pH 4·0 to 4·5.
B_1	4½–18″	Reddish-brown to orange-brown, loose and friable, structureless loam, containing various amounts of sandstone and conglomerate stones. This horizon is well-drained and contains numerous roots throughout the layer; pH 4·5 to 5·0.
B_2	18–22″	Dark reddish-brown, very compact, slightly mottled clay loam with irregular cloddy structure. Numerous small stone fragments and gravel are solidly embedded in the clay loam. Very few roots found in this layer, pH 5·0 to 5·5.
C	22″	Dark brown, very compact clay loam to clay with small stone fragments embedded in the clay as in B_2. The change from B_2 to C is very gradual. Roots are very scarce, stones and boulders are numerous; pH 5·5 to 6·0.

The Queens Sandy Loam is very similar to the loam, excepting that it has a somewhat lighter texture in the "A" and to a lesser extent in the "B_1" horizons. It is often found as a transition between the Queens Loam and the Riverbank series. Due to the somewhat more sandy nature the "A_2" horizon of the Queens Sandy Loam is sometimes a little thicker and more leached than in the case of the Queens Loam.

The clay loam is slightly heavier in texture than the loam in the "A" and to a lesser extent in the "B_1" horizons. Largely because of this difference in texture the "A_2" has not been developed to the same extent. It varies from ½ to 2½ inches in thickness and is purplish-grey to light-grey in colour. The clay loam has, as a rule, a somewhat smoother topography than the other types of the series. The cultivated layer, when depleted in organic matter, tends to bake and crack when dry and is difficult to work. Most of the clay loam is found in the northeastern corner of the area between Grand Lake and Washademoak River.

The most important phases that were mapped in the Queens series are the stony, gravelly and shallow phases. The stony phase has been mentioned earlier and is self-explanatory. The gravelly phase is usually associated with the loam and sandy loam, although it may also occur on the clay loam. Small stones

PLATE 1

FIG. 2.—Exposed rock of Pre-Carboniferous formation. The weathered rock is very soft and crumbly. Note the steep incline of the unweathered rock which provides good drainage.

FIG. 3.—Road cut through the Riverbank Sandy Silty Loam. Recent rain has removed all the loose soil showing distinctly the alternate layers of silt and sand.

Fig. 4.—Road cut through the Lower Carboniferous formation near Kingsclear, N.B. The white streaks are light greenish coloured gypsum rocks, while the dark coloured material consists of bright red mud-stone, containing often as much as 80 per cent calcium carbonate.

Fig. 5.—Pasture field reverting back to forest. The bare slope has been eroded and severely burned prior to clearing. The soil on the slopes and on top of the hill consists of Queens Loam, while the soil in the foreground is Kings Loam.

Fig. 6.—Rolling land on Pre-Carboniferous formation. Note the sparse grass cover on eroded Carleton Loam in upper right-hand corner and the dense sod on Washburn Clay Loam in foreground where some of the eroded soil has been deposited.

Fig. 7.—Permanent pasture on stony phase of Queens Loam. Ridges like the above are expensive to break and suffer from erosion when cultivated.

Plate III

Fig. 8.—Strawberries on Queens Loam gravelly phase in the Grand Lake district. No commercial fertilizer has been used on the right, while on the left 500 lb. of 4-8-10 fertilizer has been used per acre at planting. All of the land received a dressing of 20 tons of manure a year in advance of planting.

Fig. 9.—Hay meadow on undulating Carleton Loam. On the right clover and timothy after the ploughing down of a good crop of aftermath three years previous. On the left the aftermath has been cut for hay and 80 per cent of the present vegetation consists of paint brush, sorrel and poverty grass. All the land has been handled in a similar manner during the last two years.

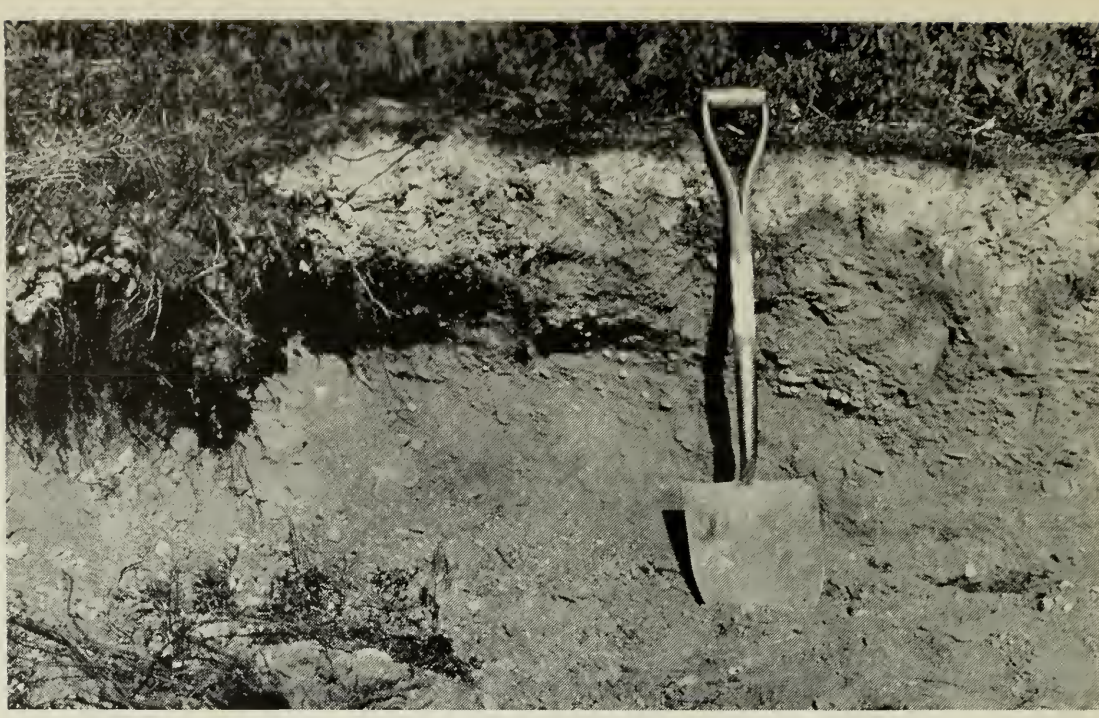


Fig. 10.—Profile of Gagetown Gravelly Loam. The compacted hardpan is found immediately below the grey layer. The subsoil below the compacted layer is loose and deposited in layers of various sized gravel and sand. Compacted boulder clay is found at 44 inches.

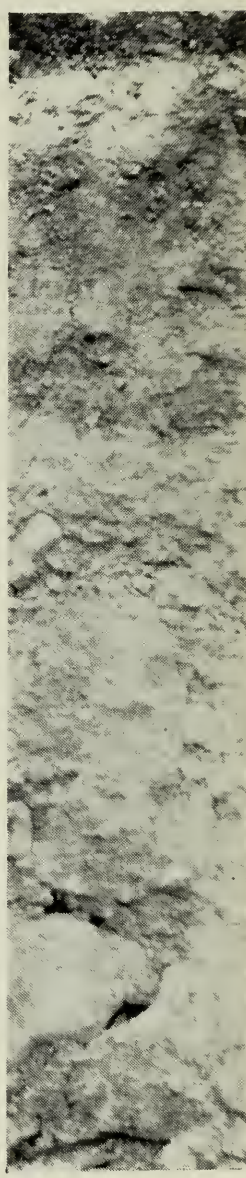


Fig. 11.—Right: Undisturbed Carleton Clay Loam. Left: Undisturbed Riverbank Sandy Loam.

of gravel size are quite numerous in the "A" and "B" horizons of this phase. These gravel fragments provide for a somewhat more open and well-drained condition in the soil. This phase is most frequently present along the shores of Grand Lake and Washademoak River and also at an intermediate position between the Queens Loam and the Riverbank series. The shallow phase of the Queens series is found on the steeper slopes where conditions are favourable for erosion and where a considerable amount or all of the "A" horizon has been eroded, thus causing a truncated soil. Such soils are very low in organic matter and are reddish-brown in colour.

Agriculture.—The Queens soils are the best agricultural soils on the Pennsylvanian formation and the largest percentage of cleared and cultivated land in the area is found on them. Nevertheless, a large area of the Queens soils has never been cleared. This is largely due to the fact that these soils are scattered throughout the district in small areas and often occur in long, narrow, irregularly shaped strips of land. In many cases the Queens soils form islands in the poorer drained Kings and Cambridge series and this is unfavourable from the point of view of settling the land.

The normal forest cover on the Queens soils consists chiefly of spruce, fir, white birch, poplar, some yellow birch and maple, white pine and jack pine. In cases where the land has been cleared and has subsequently reverted to forest, the tree cover consists almost entirely of spruce. In some cases where severe and repeated forest fires have destroyed the tree stands, the land often remains barren for a long time and the trees that establish themselves are not necessarily typical of the tree cover of the Queens series.

The natural fertility of the Queens soils is not very high, which is clearly demonstrated by the fact that crop yields are low if no fertilizer has been applied to the soil. On the other hand good yields can be obtained if sufficient manure and chemical fertilizers are used. The chemical analyses of these soils, presented in table 9 substantiate these observations. The table shows that the total amounts of phosphorus (P_2O_5), potassium (K_2O), calcium (CaO) and magnesium (MgO) in these soils are comparatively low. The amounts of available phosphorus, potassium, calcium and magnesium as measured by the Morgan Spot Test, are definitely deficient for satisfactory crop production. The data also indicate that the amounts of total and available nutrient elements in the "A_0" and "A_1" layers are high. This fact should be taken into consideration in the clearing of land for agricultural purposes. In many of the newer agricultural sections, and often even in the older districts, the land is severely burned when virgin land is broken up for cultivation. While a good burn will greatly ease the task of clearing, such a procedure will unfortunately destroy the organic matter on the surface of the soil and will cause the loss of a considerable portion of the nutrients, either by volatilization or subsequent leaching. Usually fairly good crops can be obtained for a year or two on newly broken land that has been severely burned, but in subsequent years the crops will be very poor. Thus, by burning the land during clearing operations the fertility of the soil can be destroyed and it may take at least 10 years or more of intensive farming in order to return to the soil what has been lost in a few hours.

Severe forest fires during dry years on the well-drained Queens soils not only destroy the organic matter but also create enough heat to sterilize the surface layer of the soil. As a result, trees re-establish themselves very slowly until such times when microbiological life of the soil has been built up again. Thus the loss caused by forest fires on the dry Queens soils is greater than the value of the trees alone; the damaging influence on the soil may be noticed for many years to come and in some cases of severe repeated burns it may be permanent so far as the present generation is concerned. Since burning is an important step in the clearing of new land, great care should be taken to burn only at such times when the least damage will be done to the soil. It is

advisable to burn the trash in the late fall when the ground is wet and frozen. The present legislation regarding burning, which was passed in order to prevent forest fires, will help a great deal in preserving the fertility of the soil.

The chemical analysis indicates that the "A_2" horizon is very deficient in organic matter and in most of the essential nutrient elements. The incorporation of the surface layer of organic matter into the soil makes up to some extent for the deficiencies in the "A_2" horizon. The increase in organic matter, besides improving the physical condition of the soil, increases the colloidal content, and thus the base exchange capacity of the soil. This is especially important in cases of the lighter-textured soils.

Many of the cultivated soils of the Queens series are low in organic matter, largely as a result of the use of unsound farm practices and soil management. This lack of organic matter is most pronounced in the clay loam, the sandy loam and in the shallow phases. It becomes necessary to add organic matter to such soils either in the form of stable manure or green manure. Many farmers keep only a limited number of cattle and the supply of manure is considerably less than what is needed for soil maintenance. In such cases hay aftermath or crops especially planted for green manuring have to be ploughed down in order to maintain the organic-matter content of the soil. The production of good hay crops and aftermath for green manuring often becomes a difficult task on such run-down farm land.

The data in table 9 show that the Queens soils are quite acid. The average reaction of the surface layer of the cultivated Queens soils is close to pH 5·0. The soil with the highest pH of 5·5 had received some wood ashes which tend to raise the pH. The lime requirement of these soils varies from 2 to 3½ tons of burnt lime (CaO) or 3 to 6 tons of carbonate of lime ($CaCO_3$) per acre. Applications of one to two tons of crushed limestone per acre have given very striking results on the Queens series with most crops, yet a very large percentage of the Queens soils have not received any lime applications as yet. The New Brunswick Department of Agriculture is to be commended on the lime policy that it has adopted during recent years. Besides urging the farmers to use lime on their land the Provincial Government has guaranteed the delivery of lime at a set low price at the nearest station anywhere in the province. Despite this generous offer educational work will have to be continued in order to induce the farmers to use lime. It may be said that liming is the prerequisite to successful farming on the Queens soils as far as general farm crops are concerned. Some crops grow better on acid soils than others. If potatoes are grown, lime should be withheld or applied sparingly several years before the potatoes are planted; on the other hand, if clover is grown for hay and aftermath for green manuring, lime is essential and it may be applied at the rates from two to four tons per acre, depending on acidity, texture and organic matter present. As a rule, the clay loam requires more lime to correct the acidity than the loam or sandy loam.

The content of total and available magnesium is low in the soils of the Queens series. Soils that have been extensively cultivated without receiving additional magnesium as fertilizer are deficient in this constituent and the crops often show symptoms of this deficiency. It is, therefore, advisable to use the dolomitic limestone when possible.

The Queens soils are mainly used for mixed farming, although in some cases more specialized farming is practised. The largest percentage of the agricultural land on the Queen series is devoted to hay and pasture. Where the organic matter has been kept up and the reaction has been corrected by liming, good timothy and red clover hay crops can be grown with a mixed fertilizer. On the sour land the full benefit of the fertilizer is not attained and, if the soil is low in organic matter, the nitrogen content of the mixture has to be increased. Good permanent pastures can be maintained by periodic top dressings with a mixed fertilizer that is high in phosphorus, and by the use of lime. Without such treatments the hay and pasture crops are very inferior and poverty grass (*Danthonia spicata*),

paint brush (*Hieracium florentinum* and *H. aurantiacum*), sorrel (*Rumex sp.*), ox-eye daisy (*Leucanthemum chrysanthemum*) and other weeds soon crowd out the better grasses and clovers. Many so-called "hay and pasture" fields, containing from 50 per cent to 90 per cent of weeds, are not worth the harvesting and have a very low carrying capacity.

Oats are the chief grain crop grown in this district on the soils of the Queens series. On a well kept Queens soil, using a moderate application of mixed fertilizers, a yield of 60 bushels is considered a good crop. Barley is not grown very extensively and there is room for an increase in barley production. Buckwheat is commonly grown for grain and as a green manure crop. Clover is much superior as a green manure crop but in cases where the land has been run down to such an extent that clover will not grow successfully, buckwheat can be used to good advantage for this purpose.

Potatoes are frequently grown on the Queens Loam and Sandy Loam on a small scale. Due to the comparatively low fertility of this soil, large-scale commercial potato growing is not profitable on the Queens soils as large quantities of fertilizers are required to produce a good crop.

Small family orchards are frequently encountered on favourable locations of the Queens Loam. The only commercial orchards on this soil are located at Gagetown and to a lesser extent at Kingsclear. The well-drained, deep Queens Loam in which the compacted layer is at least 30 inches below the surface, is well suited for the growth of apple trees. However, it is difficult to find uniform areas of any size where the soil extends to this depth. If the compacted layer comes closer to the surface than 24 inches, the soil is not suited for apple trees as the compacted soil interferes with proper root development. Patches of somewhat ill-drained soil, too small to map, usually occur in the Queens Loam and these are not favourable for apple orchards. Such ill-drained patches should be underdrained before planting or while the trees are still quite young. The installation of drains, however, is a difficult and expensive proposition, due to the stony nature of the Queens Loam. Wherever patches of ill-drained and shallow soils occur the trees are more subjected to winter-killing and the orchard becomes patchy.

On the gravelly phase of the Queens Loam and Sandy Loam along the shores of Grand Lake and Washademoak Lake large acreages of strawberries have been grown in recent years. This soil seems to be exceptionally well suited for this crop and high yields of good quality are produced on it. The natural fertility of this soil is not very high and liberal applications of barnyard manure applied in the year previous to planting and followed with a 4-8-10 fertilizer at planting, produce good results (Fig. 8). Lime is not essential for this crop as the plants prefer an acid soil. The heavier loams and clay loams are not suitable for the production of this crop.

KINGS SERIES

The soils of the Kings series are the most common soils on the Carboniferous formation in the surveyed area. They are always found in association with the Queens soils but whereas the latter are situated on the well-drained positions, the Kings soils are found on poorer-drained positions, on the bottom of slopes and on the smoother upland. In some cases the Kings soils have also been mapped on comparatively steep slopes where one would expect to find the Queens series. These occurrences are due to underground seepage which causes a wet condition in the soil and favours the development of a profile typical to that of the Kings series. In general it may be said that the Kings soils are found on somewhat smoother topography than the Queens soils and the average topography varies from gently undulating to gently rolling. Partly due to the smoother topography and partly due to the presence of larger amounts of organic matter in the

surface layer, the Kings soils are not subjected to severe erosion. In cases where the Kings soil is located at lower elevations adjacent to cultivated and eroded slopes of the Queens soils, some silting may take place.

Stones and boulders are encountered on the Kings series similarly as on the Queens soils and the stony phase was mapped wherever the stones were so numerous as to interfere with cultivation. The stones and boulders are of similar origin and nature as those found on the Queens soils.

The cultivated Kings soils have a dark chocolate brown to black loamy surface layer which is underlain by a yellowish-brown mottled and cold layer. At a depth of from 20 to 30 inches the soil is underlain by a dark brown very compacted boulder clay to clay loam.

Three soil types of the Kings series have been mapped as shown in the scheme of classification, namely, the loam, the sandy loam and the clay loam. The Kings Loam is the most common soil of the series. The profile description of this type, as found under virgin conditions, is given below.

Horizon	Depth	Description
A_0	0 –3″	Semi-decomposed leaf mat consisting chiefly of moss, coniferous foliage and the odd deciduous leaves (mainly white birch and poplar). Numerous fine rootlets are interwoven throughout this layer. pH 4·0 to 4·5.
A_1		Usually absent, occasionally thin traces of dark brown friable loam containing a large amount of fairly well decomposed organic matter can be found.
A_2	3–7″	Light grey to white loam, slightly mottled. Orange streaks along root channels are frequently observed. The depth of this layer varies considerably and occasionally it is 10 inches thick. The soil has a faintly visible platy structure and is very compact when dry. Numerous roots are present, pH 4·0 to 4·5.
B_1	7–16″	Greyish to yellowish-brown, badly mottled loam. The soil is structureless and slightly compacted, during wet seasons it is usually soggy and water seeps in rapidly. Sandstone fragments are quite numerous, pH 4·5 to 5·2.
B_2	16–26″	Dark brown loam to clay loam, less severely mottled than B_1. The soil is compacted and has an irregular lumpy structure. Stone fragments as in B_1, pH 4·8 to 5·5.
C	26″	Reddish-brown boulder clay to clay loam slightly mottled. Very compact with some gravel and small stone fragments firmly embedded in the clay. Very few roots found in this layer, pH 5·0 to 5·8.

When cultivated, the surface layers "A_0" "A_2" and the upper part of "B_1" are mixed. It usually takes several cultivations and often many years to mix these layers thoroughly. In cases where the "A_0" and "A_2" are very thick the lower layer of the "A_2" is not disturbed and patches of white are turned up on old land whenever the plough goes beyond the usual depth. The soggy condition in the subsoil is usually somewhat improved on cultivated land but during wet seasons water invariably seeps in immediately above the compacted layer

In the sandy loam the "A_2" horizon is usually somewhat deeper and more developed and the change from "B_1" to "B_2" is more distinct than in the loam. In the clay loam the "A_2" is usually thinner and less developed and the transition from "B_1" to "B_2" is less distinct than in the loam.

Agriculture.—The Kings soils are not so well adapted for agriculture as the soils of the Queens series. Although considerable areas of Kings soils have been cleared for cultivation at different times, much of this land has reverted back to woods in a comparatively short time. Many farms on which the largest percentage of the land consists of Kings soils have been abandoned. The tree cover of the virgin Kings soils consist mainly of conifers, such as, spruce, fir and cedar. White birch, alder, willow and poplar are also frequently found, while pine, maple and yellow birch are rather scarce. Some of the best stands of pulpwood found at the present time are on this series. Due to the moist conditions of the soil, the organic matter has not been destroyed to any appreciable extent

by the bush fires that have swept the country from time to time. The potential seed-bed of the tree seedlings has been preserved and tree growth usually reappears faster after a burn than on the well-drained Queens soils.

Most of the cleared land is in pasture and only relatively small areas are under cultivation. The pastures have, as a rule, a low carrying capacity and the species of herbage are of poor quality. As trees are the natural vegetation, young seedling trees have to be frequently cut down on the permanent pasture fields. Due to the wet conditions during the spring and rainy periods of the year, it is often difficult to establish a good sod, as the cattle puncture the sod with their hoofs. For this reason the cattle should be kept off during such wet seasons.

The cultivated soils of the Kings series are usually located near the buildings and in such places where strips of this soil cross cultivated land of the Queens series and it would be inconvenient to break the run of the field. Hay is the main crop that can be grown with any degree of success. Although the natural fertility of the Kings soil, as indicated by the amount of organic matter and of other nutrient elements present, is just as high if not higher than that of the Queens soils, poor drainage and the resulting poor physical condition render this soil unsuitable for many crops. On the better-drained Kings soils grain and root crops are frequently grown. During dry years fairly good crops are produced, while during an average wet year the crops are very backward and produce poor yields.

The agricultural value of the Kings soils can be greatly improved by the installation of underdrains. However, due to the stony nature of the soil and the low fertility of the land, it is questionable whether the land will pay for the installation of drains and for the lime and fertilizers which must be added before satisfactory crops can be grown. As a rule, underdrains are confined to small patches and strips of land that are surrounded by the well-drained Queens soils and that interfere with the proper management of larger fields. On slopes of ridges where the ill-drained condition of the Kings soils is due to underground seepage, conditions can be greatly improved by open ditches and drains. The drains must cut across the slope and extend well into the compacted subsoil in order to cut off the water from above.

The drained Kings soils produce good crops of grain and hay. Organic matter is, as a rule, abundant on these soils and erosion is of no importance. This soil is highly acid and the use of lime produces good results. An application of 2 tons per acre is usually sufficient for the loam, whereas 3 to 4 tons are required for the clay loam.

CAMBRIDGE SERIES

The Cambridge series is found in close association with the Kings soils. These soils are very similar in some respects and their main difference is in the degree of ill-drainage, the Cambridge series being poorer drained. They are usually located in depressions and on slightly undulating to level land. Erosion does not take place to any extent on these soils and silting is of very little importance.

Stones and boulders are frequently found on this soil series and they are similar in nature to those found on the other soil series on the Carboniferous formation.

The cultivated Cambridge soils have a black somewhat mucky surface layer four to eight inches deep which is underlain by a yellowish-grey badly mottled "glei" layer. At a depth of 18 to 30 inches the soil is underlain by compacted slightly mottled boulder clay.

Three types of soil have been mapped in the Cambridge series, the loam, the sandy loam and the clay loam. The Cambridge Loam is the most common soil of the series. A profile of a virgin Cambridge Loam may be described as follows:

Horizon	Depth	Description
A_{00}	0–4″	Raw undecomposed moss mixed with some coniferous foliage.
A_0	4–6″	Semi-decomposed organic matter consisting of remains of moss and coniferous foliage and interwoven by numerous small roots; pH 3·8.
A_2	6–10″	Light grey badly mottled loam, which turns white on drying and has numerous rusty spots and streaks along root channels. It becomes very hard when dry, contains numerous roots and has a pH of 4·0.
G	10–15″	Yellowish-grey very badly mottled loam, oozy and sloppy when wet and stone hard when dry; pH 4·0 to 4·5.
B	15–20″	Yellowish-brown, compacted and mottled clay loam; pH 4·5 to 5·0.
C	20″	Dark reddish-brown, slightly mottled and very compacted boulder clay to clay loam. It has an irregular structure and numerous small stones are solidly embedded in the clay. Roots are absent; pH 5·5.

The sandy loam is usually found where the Cambridge series borders the Queens series. The sandier surface soil is probably washed in from the higher lying land. The "glei" horizon is usually found in the lower part of the sandy layer.

In the clay loam the "glei" layer is usually found near the surface and the change from "G" to "B" is not so abrupt as in the other two types.

Agriculture.—Only a very small percentage of the Cambridge soils has been cleared and is under cultivation. When cleared the land usually reverts back to forest in a very short time. The tree cover of the virgin land consists largely of black spruce, cedar, tamarack, hemlock, alder and willow. The trees are usually very slow growing and remain small in size.

The cleared land consists mainly of permanent pastures which are of poor quality and have a low carrying capacity. It is usually difficult to establish a good sod due to the wet and soggy condition of the soil. The cultivated land, even when drained, produces poor crops as the physical condition of the soil is poor and the leached layer quite thick. The Cambridge soils are submarginal agricultural soils and farms containing large proportions of these soils should not be settled.

Soils on Glacial Till of Pre-Carboniferous Formation

The Pre-Carboniferous formation occupies only 9·5 per cent of the surveyed area and is found in the western section of the area as has been indicated earlier. The soils on this formation differ in many respects from the soils on the Middle Carboniferous formation. The drift and till on the Pre-Carboniferous formation contains more lime and as a result, the soils of this group are not so severely leached as the soils on the Pennsylvanian formation. The organic matter in the former is usually more friable and in a better state of decomposition than in the latter and the subsoil is not so compact.

Two soil series have been mapped on the Pre-Carboniferous formation, namely, the Carleton and the Washburn. These soils are always found in association with each other and have certain characteristics in common. They differ in respect to drainage and the effects that drainage has had on the soil profile.

CARLETON SERIES

The Carleton soils are the most important agricultural soils on the uplands of the surveyed area. They are situated on well-drained slopes and ridges and correspond in this respect to the Queens series on the Pennsylvanian formation.

The topography of the Carleton series varies from gently undulating to gently rolling on the clay loam, and from undulating to hilly on the loam and sandy loam. The changes in topography are very frequent and thus it was not possible to map all the different topographic phases on the small scale that was used. On the steeper slopes erosion plays an important role in soil management.

Stones are frequently encountered in the soil profile and on the surface of the soil. They are usually flat angular schistous and slaty fragments varying greatly in size. The soil is underlain at various depths by slaty and schistous bed-rock which usually has an incline of 45° to 80°. Small cracks along the line of cleavage usually provide for good drainage. In places where the bed-rock is covered with 20 inches or less of soil the soil was mapped as the "shallow" or ledgy phase.

The cultivated Carleton soils have a light brown to chocolate brown friable surface soil. The colour varies considerably, depending on farm practices used and the amount of organic matter that has been incorporated into the soil. The reaction of this layer varies from a pH of 5·2 to 5·8. The surface layer is underlain by a reddish brown friable, loamy layer which shades off into a greyish brown colour. At 24 to 30 inches the soil is underlain by a brownish grey to grey slightly compacted clay loam.

There are slight variations in texture, pH and degree of leaching in the Carleton series. The degree of leaching usually increases and the pH decreases as the texture becomes lighter. It is also generally found that a well-drained porous soil on top of ridges and knolls is more acid and more leached then the average Carleton soil. Down the slope the reaction of the soil gradually increases and the degree of leaching decreases. This gradual change down the slope is partly connected with the nature of the parent material of the soil. The parent material of the Carleton series contains considerable lime, which on weathering, is liberated into the soil and subsequently washed down to the lower levels. This raises the pH of the lower lying soils and consequently restricts the leaching process. On the Queens series this change is not noticeable due to the lack of lime. In the latter the lower lying soils are usually more acid and more leached because more water passes through the soil.

Three types of soil were mapped in the Carleton series, namely, the loam, the clay loam and the sandy loam. The Carleton Loam (Fig. 11) is the most common soil type of the series and a description of a representative profile, as found under virgin conditions, is given below.

Horizon	Depth	Description
A_0	0 –1″	Undecomposed leaf mat consisting chiefly of deciduous foliage.
A_1	1 –3″	Dark brown to black fairly well decomposed organic matter intermixed with the mineral soil and interwoven by numerous roots. Earth worms are frequently found in this layer; pH 4·0 to 4·5.
A_2	3 –4½″	This layer varies considerably in depth, in some cases it is not more than one-half inch thick, while in other cases it forms pockets and tongues along root channels 8 inches deep. It consists of light grey to white loam with a slightly developed platy structure. It is friable and contains numerous roots; pH 4·2 to 4·7.
B_1	4½–5″	Reddish-brown loam, structureless and friable. Stones of various size are frequently found but these do not effervesce with acids. Roots are numerous; pH 4·8 to 5·5.
B_2	15 –30″	Yellowish to greyish-brown clay loam of coarse granular to nutty structure, fairly loose and friable. Fresh surfaces of rock fragments effervesce slightly with acid. Numerous roots; pH 5·4 to 6·0.
C	30″	Grey somewhat compacted clay loam to clay with irregular lumpy structure, contains numerous shale and slate fragments, which effervesce when treated with acid. Few roots are present; pH 5·6 to 6·2.

In the sandy loam the "A_2" and "B" are slightly lighter in texture. The "A_2" is somewhat deeper and the "B" slightly brighter in colour. It is often found as a transition soil between the Carleton Loam and the Riverbank series. In the clay loam the "A_2" is slightly less developed than in the loam. The "B_1" has a duller colour and occasionally traces of mottling can be observed in the "B_2". The change from "B_1" to "B_2" and from "B_2" to "C" is very gradual and often hardly noticeable in the clay loam. The cultivated sandy loam is usually somewhat lower in organic matter and lighter in colour than the loam, while the clay loam in turn is darker in colour and higher in organic matter than the loam.

Agriculture.—The largest percentage of cleared and cultivated land in the western section of the surveyed area consists of the Carleton series. However, considerable areas of these soils are still in woods and probably will never be brought under cultivation. This situation is largely due to the layout of the farms in long narrow strips and the uneven topography. The latter does not permit the layout of roads at definite intervals and many sections of the Carleton soils remain inaccessible.

The tree cover of the typical Carleton soils consists mainly of deciduous trees with yellow birch, beech and maple dominating. Poplar, white birch, spruce and fir are present to a lesser extent. Forest fires are a great hazard on the Carleton soils, as the burning is usually so severe that all the organic matter on the surface of the soil is destroyed.

The Carleton series comprises good agricultural soils suited to a wide variety of crops. Diversified farming is practised in the western section of the surveyed area on the Carleton soils. Harvey, in the southwestern corner of the area, is a dairying district and is well known in Eastern Canada for its Jersey cows and Keswick Ridge is a well known apple orchard area in New Brunswick. In some localities potatoes are being grown extensively on this soil, while in most cases mixed farming is being practised. Although these soils are much superior in productivity to the Queens soils, they are not very well supplied with certain of the major elements as is shown in table 9, and they respond to fertilizer treatments. The data in the table indicate that the total lime and magnesia content of the soil is not very high yet it is considerably higher than in the case of the Queens soils, while the available lime and magnesia are medium high. In actual practice the use of lime at the rate of one to two tons per acre produces remarkable results with grain and hay, especially clover. The dairy industry at Harvey is mainly based on the production of large yields of hay and clover. The ploughing down of clover aftermath and the application of manure ensure the supply of organic matter and the general fertility of the soil (Fig. 9). The soils that have been cropped for a considerable time tend to become depleted in magnesium. The latter can be supplied in the form of dolomitic limestone. The soils that are used for potato growing should not be limed. The available phosphorus and potash are very low in this soil as indicated in the table, although the total contents of these elements in the surface layer are fairly high. Under field conditions complete fertilizers give very good results.

The clay loams when properly managed produce better yields of hay and grain than the other two types. This soil tends to crack when dry and it is, therefore, important to keep up the supply of organic matter. The sandy loam is well suited for potato growing and it is often used for this purpose. The hay and grain crops usually are not as large on this soil type as on the loam and clay loam.

The shallow and ledgy phase of the Carleton Loam, where the bed-rock is found at about 20 inches, produces very good crops if the season is not extremely dry. Many of the orchards in the Keswick Ridge district are located on this phase and they appear to be thriving very well. The roots seem to penetrate to considerable depth along the crevices in the underlying rock.

On the steeper cultivated slopes erosion often becomes a serious factor and many soils have been greatly damaged (Fig. 6). In the past very little attention has been paid to this problem and practices involving erosion control will have to be introduced. The steeper slopes should be returned to forest or sodded down permanently. Crop rotation and the incorporation of organic matter should be more rigidly practised and more attention should be paid to topographic features in the laying out of fields.

WASHBURN SERIES

The Washburn series occurs in association with the Carleton series and it is usually found on the lower positions at the foot of hills and in depressions. In this respect it corresponds to the Kings series on the Carboniferous formation.

The topography of the Washburn soils varies from gently to moderately undulating and is in general somewhat smoother than that of the Carleton soils. Due to the smoother topography and the amount of run-off that is collected on the lower lying Washburn soils, they have developed under excessive moisture conditions and are generally ill-drained. On smoother topography the change from Carleton to Washburn is usually very gradual and the boundary is indefinite and difficult to trace, while under rougher topographic conditions the change is abrupt and the boundary is quite sharp.

Stones are usually found in the profile and on the surface of the Washburn soils. Where the stones and boulders are so numerous as to interfere with cultivation the soil is mapped as the stony phase. The ledgy phase has been mapped where the underlying rock is found at a depth of 20 inches or less. The stones and boulders consist chiefly of grey and blue slates and shales and the underlying rock has an incline from 45° to 80°. The weathered rocks near the surface do not effervesce with acid but the unweathered rocks in the subsoil effervesce when acid is dropped on them.

Under cultivated conditions the Washburn soils have a dark brown to black loamy to clayey surface soil. During wet seasons the soil is quite soggy unless drainage has been provided. In extremely dry seasons the soil tends to bake and crack. The surface soil is underlain by a yellowish-grey mottled clay loam, which is soggy during wet seasons and hard when dry.

Three types of soil have been mapped in the Washburn series, namely, the loam, the clay loam and the clay. The clay loam is by far the most common soil. Its profile, as found under virgin conditions, is described below.

Horizon	Depth	Description
A_0	0–½″	Undecomposed leaf mat.
A_1	½–4″	Dark brown to black medium decomposed organic matter, friable. Numerous roots penetrate this layer. Earth worms are usually found; pH 5·5 to 6·0.
A_2	4–5″	Faintly visible dark grey clay loam with slightly developed platy structure. Only traces of this layer can often be found.
G	5–15″	Yellowish-grey mottled clay loam with irregular structure. During wet seasons the water table is usually found in this layer. It contains numerous rock fragments and roots are abundant in this layer; pH 6·2 to 6·9.
B	15–24″	Dark grey to brownish-grey mottled clay loam to clay. It is slightly compacted and has an irregular structure. Contains many rock fragments. Roots are not as numerous as in G; pH 6·2 to 6·9.
C	24″	Brownish-grey slightly mottled clay loam to clay, compacted, irregular structure, contains numerous rock fragments which effervesce when treated with acid; pH 6·8 to 7·5.

The surface layer of the Washburn Loam is somewhat lighter in texture and its "A_2" horizon is somewhat more distinct and slightly more acid than in the case of the clay loam. The "glei" horizon is also somewhat sandier and more defined. The cultivated layer of the loam is quite friable and does not bake to any extent under dry conditions.

In the Washburn Clay the "A_2" horizon is usually absent and the pH is generally higher than in the clay loam and loam. The change from layer to layer is very gradual in the clay. The clay bakes very hard and cracks when dry and during wet seasons the water remains on the surface for some time in the depressions and on more level land.

Agriculture.—The natural fertility of the Washburn soils is fairly high but due to their poor drainage and physical condition only comparatively small areas are under cultivation. Similarly to the Kings series, cleared fields of Washburn soils tend to revert back to bush.

The tree cover of the Washburn series consists chiefly of mixed woods with conifers dominating. The most common trees found on these soils are, cedar, hemlock, tamarack, alder, willow, white birch, poplar, spruce and fir. Due to the wet soil conditions forest fires and the loss of organic matter due to this cause, are not very serious.

Most of the cultivated land of the Washburn series is devoted to hay and pasture crops. When properly managed and if cattle are kept off during the wet periods to prevent puncturing of the sod, the pastures produce good yields of relatively high quality herbage. Thick stands of white clover, bent grasses and blue grasses are frequently found on such pastures. On the better drained positions the Washburn soils produce good hay and grain crops. If drainage conditions are improved by surface and underdrainage, the crop yields are much superior. This soil is not suitable for potato growing nor for apple trees, strawberries and other similar crops.

The supply of organic matter is usually adequate in these soils and will not likely become depleted under reasonable systems of farm management. The crops will respond to nitrogen fertilizers in the spring before the micro-organisms have an opportunity to render the soil nitrogen available to the plants. The available phosphorus and potash as indicated by the spot tests is very low. The total contents of these constituents do not vary to such a large extent in the soil profile as in the case of the other soil series. As a rule the Washburn soils respond to complete fertilizer treatments. The Washburn soils are the only upland soils in the area that do not require lime for any crops. As seen in table 9, the reaction of the surface soils is slightly acid to neutral and the lime requirement is low.

The soils of the Washburn series are not subjected to soil erosion and sometimes silting may take place on these soils. (Fig. 6). The agricultural value of this soil series depends largely on drainage conditions. With improved artificial drainage good crops of hay and grain can be produced, without this improvement the crops will greatly depend on climatic conditions and will suffer during wet years. The installation of underdrains may prove to be very expensive due to the stony nature of the soil, nevertheless, the Washburn soils are more fertile than the Kings and Cambridge soils, and under certain conditions it should be well worth while to go to the expense of underdraining the soil.

Soil Series on Stratified Water-Worked Parent Materials

The soils on the water-sorted and water-deposited parent materials occupy approximately 20 per cent of the surveyed area and are mainly found in the valleys of the St. John River and its tributaries and along the shores of Grand Lake and Washademoak Lake. They differ greatly in their productive capacity

and in the degree to which the process of podsolization has influenced the soil profile. They have been subdivided into three groups according to their parent materials and their profile characteristics, as has been indicated earlier.

Soils on Gravelly Outwash, Kames and Eskers

The parent material of these soils consists of stratified layers of sand and gravel. These layers vary considerably in thickness and differ from each other in the size and colour of the individual particles and in their compactness. The depth of the gravel varies from 3 to 4 feet to 20 feet and more. They are found on outwash and beaches along river valleys and streams and on isolated kames and eskers. The kames and eskers are, as a rule, not very large, while the beaches may run for several miles; the largest of them are found between Gagetown and Upper Gagetown.

Numerous gravel pits are found along the roadsides on this formation. The quality of the gravel for road construction varies with the different layers. The surface layers are usually discarded as they contain too much weathered material. The shaly gravel is also not suitable for road construction.

GAGETOWN SERIES

The soils formed on the gravelly parent material were mapped as the Gagetown series. Due to their mode of deposition considerable variation is found in the Gagetown series. All the soils of this series are well drained and due to the ease with which water percolates through the soil and due to their low water-holding capacity, they are often too dry and the profile shows a considerable degree of podsolization. The topography of the Gagetown soils varies from undulating to rolling and erosion becomes an important factor on the steeper hills. Numerous small rounded stones are found on the surface and in the profile of the Gagetown soils and occasionally large boulders are also found.

The cultivated surface soils of the Gagetown series consist of light brown gravelly loam. It is very low in organic matter and the darkness of the colour depends largely on the amount of organic matter present. The subsoil consists of reddish-brown layers of gravel and sand which shade off into grey sand and gravel. At depths of 3 feet and more the gravel is underlain by boulder clay.

Four types of soils have been mapped in the Gagetown series, namely, the gravelly loam, the sandy gravelly loam, the shaly gravelly loam and the gravelly loam—hardpan phase. The gravelly loam is the most representative soil of the series and a profile description of a typical virgin gravelly loam is given below.

Horizon	Depth	Description
A_0	0–2″	Undecomposed organic matter consisting of foliage of a mixed tree cover and is interwoven by a network of fine roots; pH 4·0.
A_1		Usually absent.
A_2	2–6″	Light grey to white coarse sandy to gravelly loam. This layer often extends downward in pockets to a depth of 12″ and 15″. It is structureless and friable and contains numerous rounded stones and pebbles varying in size from one to several inches in diameter. Roots are numerous; pH 3·8 to 4·2.
B_1	6–16″	Bright reddish-brown to orange brown gravelly loam, structureless, fairly loose and friable. Stones and pebbles are numerous; roots are abundant; pH 4·2 to 4·8.
B_2	16–24″	Gravelly loam reddish-brown in colour, somewhat darker than B_1. It is structureless and somewhat compact. Quite a few roots present; pH 4·6 to 5·2.
B_3	24–36″	Yellowish-brown gravel alternating with layers of coarse sand. The thickness of the layers and the size of individual particles vary considerably. This layer is loose and friable and contains fewer roots than the above; pH 5·0 to 5·5.
C	36″	Layers of brownish-grey gravel alternating with layers of coarse grey sand; pH 5·0 to 5·5.
D		Dark brown compacted boulder clay is found at various depths, the most common depth being 4 and 5 feet.

The sandy gravelly loam contains somewhat smaller percentages of gravel and more sand. The surface layer is more loamy and forms a better seed-bed than the gravelly loam. In the hardpan phase of the gravelly loam the B_1 horizon is cemented together with sesquioxides into a solid mass (Fig. 10). It is very difficult to break and roots seldom penetrate this layer. The hardpan phase is found in isolated patches in the gravelly loam. The only difference in the profile is the compacted condition of the hardpan layer. There are no external features indicating the presence of this compacted layer. It is difficult to explain why this compacted layer is not present in all the gravelly loam or why it is present in certain places. It is possible that differences in the original pH gradient of the soil profile caused more rapid precipitation of the sesquioxides and thus brought about the cementing of this layer.

The shaly gravelly loam differs to some extent from the other types of the series in appearance and should probably be placed in a separate series. However, it has been mapped as a type rather than a series because it is not very extensive, occupying altogether only a few square miles, and it resembles the other Gagetown soils in many respects. The parent material of the shaly loam consists of layers of gravel similar as in the case of the other soils of the Gagetown series, but the gravel fragments are flat and angular instead of rounded and are darker in colour. The weathered thin gravelly fragments near the surface of the soil are very friable and crumble easily thus the cultivated surface layer is quite loamy. The virgin profile differs from the other types of the Gagetown series in that the "A_0" is somewhat thicker and the "A_2" has a purplish to brownish tinge. The " B " horizon is somewhat darker in colour than in the Gagetown Loam. Thin layers of dark grey sand alternate with the shaly gravel in the " B " and " C " horizons and no compact layer is found in the " B ". The reaction of the shaly gravelly loam is just as low as that of the gravelly loam and very often the reaction of the " A " horizons has a pH of less than 4·0. The cultivated surface soil of the shaly gravelly loam has a greyish-brown colour with a slight purplish tinge. The darkness of the colour depends to a large extent on the amount of organic matter that has been incorporated into the soil.

Agriculture.—The Gagetown soils occupy a comparatively small percentage (3·5 per cent) of the surveyed area. As most of these soils are found in the older and settled districts in the St. John River Valley, a considerable percentage of them has been cleared.

In the wooded sections the tree cover consists of mixed coniferous and deciduous vegetation. White pine and jack pine are usually more abundant on these soils than on the other soil series in this area. Such trees as cedar, hemlock, tamarack and alder are, as a rule, quite scarce on the Gagetown soils.

Due to the open and porous nature of these soils, they have very little body and are not very productive. A wide variety of crops are grown on these soils with varying degrees of success. The hay and pasture crops produce, as a rule, low yields and these crops suffer often from drought, as the water holding capacity of the soil is very low. The pasture fields turn brown and look very bare if dry spells of two or three weeks duration are encountered. The herbage in the pasture fields, unless fertilized, is of poor quality, and poverty grass, paint brush and sorrel are among the dominant species present. The hay and pasture yields are especially poor on soils that are deficient in organic matter and due to the lack of abundant herbage it often becomes a difficult problem to build up the organic-matter content of the soil. Buckwheat has been used on some occasions for this purpose with fairly good success. Grain and potatoes are frequently grown on the Gagetown soils but liberal applications of fertilizer and organic matter have to be added before satisfactory results can be obtained. Apple orchards can frequently be found on the Gagetown gravelly and sandy

gravelly loam where the gravel is not more than five feet deep. The trees grow slowly but when a good mulch and adequate quantities of fertilizers are used very good results can be obtained. In the vicinity of Grand Lake strawberries are grown extensively on the Gagetown soils. The soil warms up very quickly in the spring and the strawberry crop matures early, producing fruit of good flavour. Other garden crops such as corn, tomatoes, potatoes, etc., are also grown to a lesser extent for the early markets.

The "hardpan phase" of the gravelly loam is of little value for agricultural purposes. Pastures are the main crops on this soil and they are in very poor condition. The shaly loam occupies only a small area and most of this is in woods. The crops grown on it are similar to those grown on the gravelly loam and their yields are very low.

The results of the chemical analysis presented in table 9 show that the Gagetown soils are very acid and have a high lime requirement. The total amounts of lime and magnesium are very low and the spot tests show a lack of these elements in available form. These results agree closely with observations made in the field, namely, that the crops respond greatly to the use of lime. Due to the small amounts of magnesium found in these soils it is well to use the dolomitic limestone. An application of one to two tons per acre increases the yields of grain and hay considerably. It should be pointed out again that crops differ greatly in their ability to grow on acid soils. In the case of potatoes lime should be avoided or else used very sparingly. Strawberries also thrive well on acid soils and the results obtained thus far from liming experiments are not striking. The same thing holds true in the case of apple orchards.

Soils on Sandy Parent Materials

This group of soils is mainly confined to the St. John River Valley and the valleys of the larger tributaries of the St. John. The parent material is very sandy and in some cases consists of 90 per cent sand. The sand has been deposited in layers on the somewhat smoother land on the bottom of the river valleys and on the lower slopes of the hills along the valleys. Below Fredericton the elevation of these sandy soils is less than 100 feet above mean sea level, while above Fredericton they are often found up to 200 feet above mean sea level. They are usually found in narrow strips (200 to 300 yards wide) although at some places they widen out to a mile and more.

Two soil series have been mapped on this parent material, the Riverbank series on well-drained positions and the Oromocto series on ill-drained positions.

THE RIVERBANK SERIES

The Riverbank series occupies approximately 4·0 per cent of the surveyed area. It is found mainly on well-drained slopes in the river valleys. The slopes vary considerably and most of them have a grade from 4 per cent to 15 per cent, although sometimes the topography is much smoother.

Stones and boulders are not so numerous on this series as on the upland soils and they are found more frequently in the subsoil than in the upper soil horizons.

The cultivated Riverbank soils consist of light brown friable sandy loam. The colour depends to a large extent on soil management and the amount of organic matter that has been incorporated into the soil. The reaction of the unlimed soil varies from pH 5·0 to 5·5. The surface soil is underlain by sandy loam to sand,

the colour of which changes from a reddish-brown to a greyish-brown and grey with greater depth. At approximately three feet it is underlain by compacted boulder clay.

Four soil types have been mapped in the Riverbank series, namely, the sandy loam, the loamy sand, the sandy silty loam and the sandy gravelly loam. The sandy loam (Fig. 11) is the most common and most extensively cultivated soil type. The profile of this soil type, as found under virgin conditions, is described below.

Horizon	Depth	Description
A_0	0 –1½″	Poorly decomposed organic matter consisting of mixed deciduous and coniferous foliage, interwoven with a fine network of roots.
A_2	1½–5½″	Light grey to white fine sandy loam. It is very friable, structureless and contains numerous roots; pH 4·0 to 4·5.
B_1	5½–13″	Reddish to orange brown fine loamy sand to sandy loam, structureless, very loose and friable, contains numerous roots and some stones; pH 4·5 to 5·0.
B_2	13 –30″	Yellowish-brown to greyish-brown loamy sand, structureless, loose and friable. Thin layers of sand, varying in colour and size of particles are usually found alternating with each other; pH 5·0 to 5·5.
C	30″	Grey, loose and friable sand deposited in layers varying in shade of colour and size of sand particles. The latter vary from very fine sand to coarse sand; pH 5·3 to 5·7.
D		At depth from 30 inches to 5 feet and occasionally deeper, the sand is underlain by dark reddish-brown to greyish-brown boulder clay. This is the characteristic subsoil of the upland soils. It is very compact and roots do not penetrate into this layer; pH 5·3 to 5·8.

The loamy sand differs from the sandy loam mainly in its coarser texture and greater porosity. The layer of organic matter on the surface of the loamy sand is somewhat thinner and the "A_2" somewhat thicker than on the sandy loam. The boulder clay is usually found at greater depth and the soil as a whole is somewhat drier.

The texture of the surface layers of the silty sandy loam is similar to that of the sandy loam. In the "B_2" and "C" horizons, however, thin layers of compacted silty loam are encountered (Fig. 3). These thin compacted layers restrict to some extent the rapid percolation of the water and slight traces of mottling are usually found immediately above these layers. As a result of the more humid soil conditions the layer of organic matter on the surface of the soil is somewhat thicker and the cultivated surface soil is darker in colour than in the case of the sandy loam.

The surface layers, i.e. the "A" and "B_1" horizons, of the sandy gravelly loam are very similar to the surface layers of the sandy loam. The subsoil "B_2" and "C", consists of a layer of fine gravel two to three feet thick. The gravel is water rounded and is found in layers of varying sized particles. At a depth of three to four feet the soil is underlain by boulder clay. The gravelly subsoil provides good internal soil drainage and acts as an underdrain.

On cultivation the upper layers, "A_0" "A_2" and "B_1" are intermixed. The thickness of the "A_2" horizon and the depth of ploughing will largely determine the amount of "B_1" horizon that is incorporated into the plough layer. In some places the thickness of the "A_2" horizon is so great that the "B_1" remains undisturbed. When the ploughing is deeper than usual, grey patches of the "A_2" are turned up in these places on old fields. Such cultivated soils consist chiefly of leached materials and are not very productive.

Agriculture.—The soils of the Riverbank series are important agricultural soils as they are mainly located in the most densely settled areas in the St. John River Valley. A considerable percentage of these soils has been cleared and is

under cultivation. The original stands of forest on the Riverbank series have either been cut down or burned over and the present tree cover consists largely of young growth. This is to some extent responsible for the heterogeneity in the tree cover of these soils. The present tree cover consists either of pure stands or mixtures of the following species, spruce, fir, white birch, poplar, yellow birch, jack pine, white pine, beech and maple.

A wide variety of crops are grown on the Riverbank soils, although the dominant type of farming is mixed farming. More land is devoted to hay and pasture than to any other crop. The yields and quality of the hay and pasture crops vary greatly according to the farm practices used and the fertilizer treatments that the soils have received. The application of barnyard manure and the ploughing down of green crops to maintain the organic matter produce good results and when supplemented with commercial fertilizers the yields can be greatly increased. Without such improvements these crops are very poor. The use of lime at a rate from one to two tons per acre produces great improvements in the hay crops and stimulates especially the growth of clover. The sandy silty loam is largely used for hay and pasture and these crops do very well, especially during dry years. On the loamy sand and sandy gravelly loam the pastures suffer considerably from drought during the dry years.

The grain crops are mainly grown on the Riverbank Sandy Loam, although they are also found to a lesser extent on the other soil types. The yields on the unfertilized soils are as a rule low but can be greatly raised by the use of mixed fertilizers, the incorporation of organic matter and the use of lime. Oats are the most common grain crop, followed by buckwheat, while barley and wheat are not very frequently grown.

Most of the commercial orchards in this area are grown on the Riverbank soils. The sandy loam and the sandy gravelly loam are very well suited for this crop. The open nature of the subsoil provides good drainage and permits good root development which is especially so in the case of the sandy gravelly loam. In cases where the compacted subsoil comes to within 24 inches or less, from the surface, the sandy loam is not so well suited for apple trees. Due to the porous nature of the soil, mulch should be used around the apple trees in order to conserve moisture. As the natural fertility of these soils is not great, the trees grow slowly and fertilizers will give favourable results. A mixed fertilizer should be used, as the use of nitrogenous fertilizers alone often causes bad results.

Among other crops grown to any extent on the Riverbank soils are potatoes, strawberries, raspberries and other small fruits. The soil is well suited for these crops but in order to produce good yields the fertility of the soil has to be built up and maintained by the use of fertilizers and the incorporation of organic matter.

THE OROMOCTO SERIES

The Oromocto soils are found in close association with the Riverbank series. They are situated on ill-drained positions on the lower lying smoother land and on slopes where underground seepage has caused poor internal drainage.

The topography of the Oromocto soils varies from gently undulating to undulating. Some stones and boulders are found but, as a rule, these soils are not as stony as the upland soils.

The cultivated soils of the Oromocto series have a dark brown to black sandy surface layer which is underlain by brownish-grey mottled sandy loam. The latter shades off into grey sand which is underlain at various depths by boulder clay.

Two soil types have been mapped in the Oromocto series, namely, the sandy loam and the sandy silty loam. The sandy loam is the most common soil type and a description of a typical profile of this type, as found under virgin conditions, is described below.

Horizon	Depth	Description
A_0	0–3″	Poorly decomposed mat of organic matter, consisting largely of coniferous foliage, which is interwoven with a network of fine roots; pH 3·8 to 4·2.
A_2	3–7″	Light grey to white, mottled, fine sandy loam. It has a slightly developed platy structure and contains numerous roots; pH 4·0 to 4·5.
B_1	7–15″	Yellowish-grey mottled sandy loam with yellow and orange streaks along root channels, structureless and fairly friable, numerous roots; pH 4·2 to 5·0.
B_2	15–35″	Brownish-grey mottled sand, deposited in alternate layers of coarse and fine sand. Loose and friable, roots are scarce: pH 5·0 to 5·5.
C	35″	Bluish-grey mottled sand deposited in layers of various sized sand. The water table is usually found in this layer, roots are absent; pH 5·2 to 5·8.
D		At depths varying from 3 to 5 feet the soil is underlain by compacted boulder clay.

The sandy silty loam differs from the sandy loam in that it has thin compacted layers of silt in the "B" horizon alternating with layers of sand. These compacted layers restrict the downward movement of water and during wet periods the water table is held above the compacted layers.

The leached "A_2" horizon is often so thick that the lower parts of this layer are not incorporated into the cultivated layer and the "B_1" remains untouched. In many cases the remainder of the grey "A_2" layer is turned up on the field, if the cultivation is deeper than usual.

Agriculture.—The Oromocto soils are not very well suited for agricultural development and the largest percentage of this series is in woods. The most common trees found on the Oromocto soils are cedar, hemlock, tamarack, spruce, fir, alder, willow, white birch, poplar and the occasional swamp maple and elm. Most of the forest has been cut over from time to time and the trees usually are small and consist of second and third growth. A considerable portion of the land that has been cleared from time to time has reverted back to bush within a comparatively short period.

The largest percentage of the cleared land is in permanent pasture. The natural pasture herbage is not of very high quality and a considerable proportion of the vegetation consists of carex, juncus and bent grasses. Due to the wet and soggy soil conditions it is difficult to establish a good sod on the Oromocto soils, as the cattle will puncture it unless they are kept off during the wet periods. Hay crops are also frequently grown and do very well on the somewhat better positions in drier years. In wet years and on the lower and wetter positions the hay crops are poor. Grain crops will grow satisfactorily only on the better positions where drainage conditions have been improved. Artificial drainage will greatly improve the value of this land.

Immature Soils on Bottom Land

The bottom land consists of materials that have been deposited recently during spring floods or have been washed down from the slopes of the surrounding hills by heavy rains during the summer months. It is found on the bottom of old water channels and river valleys and is most extensive on the flats along the shores of the St. John River and on the numerous islands in the river. Due to the recent deposition of the parent material the soils have not had sufficient time to develop a characteristic profile typical of the soils found under similar climatic

conditions on the older upland. Similar soils are referred to, under some systems of classification, as azonal soils. The lack of definite profile horizons and the gradual change in colour from the surface downward are the characteristic features of the bottom land in the surveyed area.

The topography of the bottom land is level to gently undulating. Along the shores of the river from Devon to Sheffield, where the bulk of these soils is found, the elevation is usually slightly higher than farther inland and this condition often causes ill-drained soils.

Two soil series have been mapped on the bottom land in the surveyed area, namely, the Interval series and the Rusagonis series.

THE INTERVAL SERIES

The soils of the Interval series occupy approximately 6·0 per cent of the total area and are almost exclusively found along the shores of the St. John and on the islands in the river at an elevation of 30 feet or less above the mean sea level. They are very immature, most of them being flooded annually by the spring freshets and thin layers of silt are deposited on the surface every year. Some of the Interval soils on slightly higher elevations are flooded only in years with exceptionally high freshets. The silt that is carried down by the waters of the St. John and deposited on the soil, has been gathered all along the course of the river and its tributaries and comes from different formations. A large proportion of the silt comes from the Pre-Carboniferous formation in Carleton and Victoria counties where a large percentage of the land is under cultivation and where erosion is a serious problem largely due to farm practices used.

After the recession of the spring freshets water remains for some time in the lower positions and causes an ill-drained soil. The differences in the soil profile due to drainage are not very great and for this reason the ill-drained soils have been mapped as phases, rather than series, as has been done in the upland soils.

Three soil types have been mapped in the Interval series, namely, the silty loam, the sandy silty loam and the silty clay loam. The Interval Silty Loam is the most common type of this series and a description of a typical profile is given below.

Horizon	Depth	Description
A	0–10″	Dark brown to black silty loam. It is very friable, has a granular structure and contains numerous roots; pH 6·2.
B_1	10–18″	Medium brown friable silty loam with faintly noticeable laminated structure which is mainly due to the deposition of the parent material in thin layers. This layer contains numerous roots. It has a pH 6·3 to 6·6.
B_2	18–32″	Greyish-brown, friable silty loam, slightly mottled. Thin layers varying in colour and texture which are due to the mode of deposition can be noticed; pH 6·5 to 6·8.
C	32″	Grey silty loam to silty clay loam, slightly mottled, structureless and friable. No roots present; pH 6·2 to 6·5.

The Interval Sandy Silty Loam has a larger percentage of fine sand in the "A" and "B_1" horizons than the silty loam. It is usually found where the water current is faster than in most cases and where decreases in the speed of flow and changes in the direction of the current occur. It is found near the shores of the river and near small bays and bends in the river.

The Interval Silty Clay Loam contains less sand and more clay than the other two types. It usually occurs farther inland where the current is slower. This soil shows, as a rule, somewhat more mottling than the other types and tends to crack when dry.

The ill-drained phases of the respective soil types differ from the well-drained types in that they are more mottled in the subsoil and the surface layer is somewhat deeper and darker in colour. Although the differences between the

profiles are not very great, the agronomic value of these soils differs sufficiently to justify the mapping of these phases. As the ill-drained phases are usually covered for a longer period with water, the soils warm up more slowly in the spring and the growing season of the crops is consequently shortened.

In depressions where the water remains on the land during most of the season and where the water table remains so high as to permit only marsh vegetation to grow, the soil was mapped as a swamp and as such is of little or no agricultural value. The drainage of such swampy bottom land is in most cases not feasible, as the elevation is not above the water level in the St. John River.

Agriculture.—The Interval soils occupy approximately 6 per cent of the total area and they are of considerable importance from an agricultural point of view. The better drained soils near the river are usually cleared and under cultivation, while most of the ill-drained soils are wooded. The tree cover consists largely of deciduous trees with a dense undergrowth of various shrubs.

The Interval soils are the most fertile soils in the surveyed area, but due to the frequent inundations their use is limited to certain crops. Between Devon and Sheffield a large portion of the land is devoted to market gardening. The land near the river is somewhat higher than farther inland and it floods only during years of high freshets and most of the houses are located here. The water does not remain on the land very long and as soon as the water level in the river goes down the soil dries and warms up quickly with the result that garden crops grow rapidly and mature very early. The well-drained Interval soil is well suited for market gardening, as it is fertile, friable and easy to work. The chemical analysis indicates that the Interval soils are well supplied with calcium and magnesium and that they do not require lime except in the case of some special crops. Complete fertilizers give satisfactory results with the garden and grain crops in the Maugerville district. The kind of mixture to be used depends to a large extent on the kind of garden crop grown.

Between Sheffield and Jemseg and on the islands in the river most of the cleared Interval land is in permanent hay meadows. This difference in land use is not due to soil fertility but due to the fact that the elevation of the land here is a few feet lower than at Maugerville and the land floods more frequently and remains under water for longer periods. For this reason very few farm houses are located here. The land is mainly held by farmers who live inland and have their hay meadows on the flats. Numerous hay barns are found along the shore in which the hay is stored until winter when it is hauled away. Some of the meadows have been down in sod for over 60 years and they still produce up to $1\frac{1}{2}$ tons of natural hay per acre without ever having received any fertilizer. The fertility of the land depends largely on the floods and in years of low freshets when the land is not flooded the yields are low. During recent years noxious weeds have become quite troublesome in some sections, the weed seeds having been carried in by the floods.

RUSAGONIS SERIES

The soils of the Rusagonis series are usually confined to old water channels and low flat lands excluding the St. John River flats and they occupy less than 1 per cent of the total area. The parent material of these soils has been washed off from the adjacent hills and deposited after the spring thaws and after heavy summer rains. The topography of the Rusagonis soils is gently undulating to undulating. Stones and boulders are very scarce on the surface of the soil but can occasionally be found in the subsoil. Soils of the Rusagonis series are usually considerably heavier in texture than the Interval soils, their drainage is imperfect and their profiles are immature and poorly developed.

Two soil types, the Rusagonis Clay and Rusagonis Clay Loam with their corresponding ill-drained phases have been mapped in the Rusagonis series. A profile of the Rusagonis clay loam is described below.

Horizon	Depth	Description
A	0–8″	Dark chocolate brown clay loam, granular structure; pH 5·8.
B_1	8–18″	Yellowish-brown clay loam, coarse granular to nutty structure, slightly compacted; pH 6·0.
B_2	18–30″	Yellowish-grey clay loam to clay; slightly mottled, nutty structure; compacted; pH 6·5.
C	30″	Grey to bluish-grey compacted clay, slightly mottled, irregular structure; pH 7·0.
D		At various depths dark brown boulder clay underlies the soil. In some cases the "C" is absent and the boulder clay is found at 25 to 30 inches, while in other cases it is found at 4 foot depth.

The surface soil of the Rusagonis Clay is heavier in texture and its "B_1" and "B_2" horizons have a more greyish colour than those of the clay loam. Slight traces of mottling are found closer to the surface than in the clay loam. The Rusagonis Clay is very sticky when wet and becomes very hard and cracks when dry.

The ill-drained phases of the Rusagonis soils have, as a rule, a black surface soil, quite high in organic matter. The subsoil is badly mottled and yellowish-grey in colour. During wet seasons it is too sticky and too wet for cultivation, while during dry seasons it becomes very hard and is difficult to handle.

Agriculture.—Most of the well-drained soils of the Rusagonis series are cleared and under cultivation, while the ill-drained soils are mostly wooded. The tree cover consists of mixed woods, chiefly white birch, poplar, alder, elm, cedar, fir and spruce.

The cultivated land is mainly used for mixed farming and dairy farming. This soil is very fertile and good hay and grain crops are grown on it. The reaction of this soil is slightly acid to neutral and lime is not needed for the production of the ordinary crops. Mixed fertilizers will produce good results with hay and grain crops. Artificial drainage will greatly improve the ill-drained phases and turn them into good hay and pasture land.

Organic Soils

Soils containing more than one foot of organic material on the surface were mapped as organic soils. The organic soils occupy approximately 1·5 per cent of the total area and are located in depressions with poor outlets and are generally ill-drained. The depth of the organic layer varies considerably and in some cases it is known to attain a depth of 15 feet.

The organic soils were classified into mucks and peats. The mucks are, as a rule, shallow, varying in depth from 1 to 3 feet and are underlain by a compacted badly mottled "glei" horizon. The surface 8 to 12 inches of the muck soil is black in colour and the organic material is well decomposed. The second foot is dark brown in colour and the organic matter is semi-decomposed, and if the organic soil is deeper, it is underlain by raw undecomposed peat. The peat has a semi-decomposed surface layer which is underlain by raw undecomposed peat which may vary from two feet to 15 feet in depth. The reaction of the muck soil varies from a pH of 4·5 to 5·0, while the peat is more acid and usually has a pH of 4·0 or less.

Agriculture.—Most of the organic soils are wooded and the nature of the vegetation varies considerably. The muck soils have a mixed tree cover with a fairly high percentage of deciduous trees and a thick underbrush. The trees on the peat consist almost entirely of conifers and a thick mat of moss covers the ground. Many of the swampy peat soils have a dwarfed vegetation consisting of a few stunted black spruce, blueberries, cranberries, laurel, Labrador tea, hard-hack and a thick mat of sphagnum moss.

During recent years attempts have been made to increase the production of wild cranberries on these soils. Some of the shallower peat and muck soils, that have a semi-decomposed to well-decomposed surface soil, are best suited for this purpose. The cultivated areas of muck soils are very small and consist mainly of narrow strips of land that protrude into the well-drained upland soils. They are in most cases used in a similar manner as the upland soils and hay and pasture are the main crops. The muck soils are well suited for the production of garden crops. If used for this purpose certain features of the muck soils have to be taken into consideration. They have, as a rule, a high content of nitrogen and a low content of potash. These deficiencies have to be balanced by the use of a correct fertilizer mixture.

Rough and Stony Land

Approximately 7 per cent of the Fredericton-Gagetown area consists of rough stony non-agricultural land. The topography of this land is usually quite rough and hilly and the soil is very stony and ledgy, making it impossible to use farm machinery on the land. Although this land is too rough for cultivation, good stands of forest are often found on it. The type of vegetation varies considerably and depends to some extent on the kind of formation that it is found on. In some cases the trees have been cut down on such land and the clearings are used as pasture. It is difficult to improve such pasture land as machinery cannot be used on it. It is impossible to pick up all the rocks and boulders and such improvements as can be made, must be restricted to surface application of fertilizers and the cutting down of weeds and tree seedlings by hand. As a rule, it is more advisable to let such rough land return to woods for which purpose it is better suited.

APPENDIX

TABLE 7.—APPROXIMATE AREAS OF DIFFERENT SOILS

Soil Classes	Acres		Per cent of total area	
Soils on Carboniferous formation	391,000		62·0	
Queens Series		164,000		26·0
Kings Series		180,000		28·5
Cambridge Series		47,000		7·5
Soils on Pre-Carboniferous formation	60,000		9·5	
Carleton Series		32,000		5·0
Washburn Series		28,000		4·5
Soils on Water-deposited Parent materials	126,000		20·0	
Gagetown Series		22,000		3·5
Riverbank Series		25,000		4·0
Oromocto Series		16,000		2·5
Rusagonis Series		6,000		1·0
Interval Series		38,000		6·0
Swamp		19,000		3·0
Peat and Muck	10,000		1·5	
Rough and Stony Land	44,000		7·0	
Total Area	631,000		100·0	

TABLE 8.—PHYSICAL ANALYSES OF SOME TYPICAL SOIL PROFILES

Horizon	Depth	Fine and coarse gravel per cent	Total sand 1–0·05 mm	Silt 0·05–0·005 mm per cent	Total clay 0·005–0 mm per cent	Fine clay 0·002–0 mm per cent
			Calculated on basis of 100%			
Queens Loam—	inch					
Cultivated layer	0–7	21·2	36·8	34·2	29·8	20·6
A_2	2½–5½	19·0	38·0	35·6	26·4	15·0
B_1	5½–14	35·8	41·0	30·2	28·8	20·6
B_2	14–24	24·2	44·0	28·4	27·6	21·6
C	24–36	9·0	37·5	31·7	30·8	25·8
Queens Sandy Loam—						
Cultivated layer	0–7	19·9	44·4	37·0	18·6	12·0
A_2	1½–5	13·7	42·6	41·2	17·2	10·0
B_1	5–18	15·9	54·8	24·2	21·0	10·0
B_2	18–28	20·2	42·2	33·0	24·8	9·0
C	28–40	22·0	36·4	27·6	36·0	29·2
Queens Clay Loam—						
Cultivated layer	0–7	18·8	30·8	31·2	38·0	30·0
A_2	2–6	22·1	30·6	33·6	35·8	24·4
B_1	6–15	19·7	32·2	31·2	36·6	27·4
B_2	15–24	22·3	31·6	34·6	33·8	28·0
C	24–36	28·0	28·0	33·4	37·6	30·5
Queens Loam-Gravelly phase—						
A. (Cult.)	0–7	39·2	39·0	34·4	26·6	19·4
B_1	7–18	52·5	49·8	30·6	19·6	15·4
B_2	18–32	50·3	50·8	27·6	21·6	16·6
C	32–40	40·0	27·2	42·0	30·8	24·0
Kings Loam—						
Cultivated layer	0–7	22·5	34·8	35·0	30·2	21·8
A_2	2–6	13·1	22·0	53·6	26·4	19·4
B_1	6–14	27·6	32·8	42·2	25·0	18·0
B_2	14–26	33·5	31·2	32·4	36·4	28·0
C	26–36	31·8	30·6	33·0	36·6	30·0

TABLE 8.—PHYSICAL ANALYSES OF SOME TYPICAL SOIL PROFILES—*Concluded*

Horizon	Depth	Fine and coarse gravel per cent	Total sand 1-0·05 mm	Silt 0·05-0·005 mm per cent	Total clay 0·005-0 mm per cent	Fine clay 0·002-0 mm per cent
			Calculated on basis of 100%			
Kings Clay Loam—						
Cultivated layer	0–7	13·8	30·6	33·4	36·0	27·4
A_2	2–4	5·2	30·6	36·8	32·6	25·0
B_1	4–15	5·5	31·2	37·6	31·2	24·8
B_2	15–22	16·7	32·2	31·8	36·0	26·2
C	22–36	14·1	30·4	29·1	40·5	33·0
Carleton Loam—						
Cultivated layer	0–7	20·3	37·0	43·6	19·4	14·8
A_2	3–5	9·7	35·4	42·6	22·0	15·4
B_1	5–7	19·0	38·2	38·8	23·0	14·8
B_2	17–31	18·0	39·0	29·6	31·4	22·4
C	31–44	17·3	35·0	26·6	38·4	33·0
Carleton Sandy Loam—						
Cultivated layer	0–7	31·3	50·6	30·4	20·2	16·2
A_2	3–4½	27·7	43·6	35·8	20·6	13·0
B_1	4½–15	36·7	46·0	35·0	19·0	13·6
B_2	15–30	36·5	40·6	36·4	23·6	16·4
C	30–40	29·5	37·4	31·0	31·6	26·2
Carleton Clay Loam—						
A (Cult.)	0–8	13·8	37·6	37·6	24·8	18·0
B_1	8–17	19·0	38·4	34·0	27·6	22·6
B_2	17–32	17·9	38·4	27·6	34·0	28·0
C	32–45	18·2	35·4	25·0	39·6	33·8
Washburn Loam—						
Cultivated layer	0–8	5·6	35·2	41·4	23·4	16·0
A_2	4–5	11·5	34·6	43·0	22·4	15·6
B_1	5–15	12·8	37·0	40·6	22·4	14·6
B_2	15–24	17·0	40·0	33·6	26·4	21·6
C	24–36	34·3	20·7	44·5	34·8	28·6
Washburn Clay Loam—						
A (Cult.)	0–8	24·2	28·0	41·6	30·4	20·6
B_1	8–16	20·3	38·0	33·4	28·6	22·8
B_2	16–27	20·6	33·0	26·6	40·4	32·6
C	27–36	20·6	31·2	31·2	37·6	31·4
Gagetown Gravelly Loam—						
Cultivated layer	0–6	30·2	55·0	31 5	13·5	11·0
A_2	2–6	39·1	70·5	23·0	6·5	5·0
B_1	6–16	47·8	72·0	12·2	15·8	12·0
B_2	16–24	41·3	88·0	6·5	5·5	4·0
B	24–36	47·2	91·8	7·0	1·2	1·0
C	36–45	31·7	96·5	2·5	1·0	0·5
Gagetown Shaley Gravelly Loam—						
Cultivated layer	0–8	20·5	44·7	27·7	27·6	21·4
A_2	2–6	28·0	46·5	30·9	22·6	19·2
B_1	6–16	72·5	69·2	13·6	17·2	16·2
B_2	16–28	66·4	77·0	9·3	13·7	11·4
C	28–40	69·0	74·3	10·3	15·4	11·6
Riverbank Sandy Loam—						
Cultivated layer	0–8	0	69·5	18·9	11·6	8·3
A_2	1½–5½	0	53·8	29·8	16·4	11·0
B_1	5½–13	1·6	67·7	19·5	12·8	10·4
B_2	30–13	0	81·2	13·4	5·4	4·4
C	30–40	0	91·2	4·8	5·4	3·0
Interval Silty Loam—						
A (Cult.)	0–10	0	26·4	50·0	23·6	15·6
B_1	10–18	0	29·4	53·0	17·6	14·0
B_2	18–32	0	22·4	59·0	18·6	15·6
C	32–45	0	14·4	57·0	28·6	19·0

TABLE 9.—CHEMICAL ANALYSES OF SOME TYPICAL SOIL PROFILES (Expressed on oven dry basis)

Horizon	Depth	Hyg. moisture per cent	Loss on ignition per cent	pH	Lime requirement lb. Ca% p/a	N. per cent	P_2O_5 per cent	K_2O per cent	SiO_2 per cent	R_2O_3 per cent	CaO per cent	MgO per cent	Available P	Available K	Available Ca	Available Mg
	inch															
Queens Loam—																
Cultivated layer	0–7	1·84	5·25	4·96	5,320	·090	·085	2·60	72·70	16·97	0·74	0·10	v.l	v.l	v.l	v.l
A_0	0–1	12·35	67·10	4·10	13,500	1,334	·253	1·90	17·22	8·59	3·82	0·12	h	v.h	h	h
A_1	1–2½	2·17	6·42	4·42	17,900	·116	·169	1·45	73·18	17·14	0·42	0·09	v.l	v.l	v.l	v.l
A_2	2½–5½	1·15	2·51	4·81	6,200	·045	·026	1·55	78·65	14·72	0·38	0·07	v.l	v.l	v.l	l
B_1	5½–14	2·30	4·80	4·87	3,300	·054	·072	2·58	70·57	21·97	0·58	0·26	v.l	v.l	v.l	v.l
B_2	14–24	1·32	3·79	4·85	3,300	·043	·026	2·66	64·48	22·86	0·54	0·23	v.l	v.l	v.l	v.l
C	24–36	1·75	3·06	4·93	3,300	·028	·025	2·65	70·05	21·86	0·69	0·25	v.l	v.l	v.l	v.l
Queens Sandy Loam—																
Cultivated layer	0–8	2·26	5·81	5·00	5,050	·098	·100	2·41	70·31	17·82	1·22	0·14	v.l	l	v.l	v.l
A_0	0–1½	7·28	48·83	4·20	11,700	·683	·174	1·89	40·84	5·27	1·83	0·38	h	v.h	h	h
A_2	1½–5	0·87	2·80	4·40	5,000	·038	·032	1·75	85·74	8·46	0·24	trace	v.l	v.l	v.l	v.l
B_1	5–18	1·75	3·85	4·86	6,200	·044	·049	2·38	68·71	22·35	0·56	0·27	v.l	v.l	v.l	v.l
B_2	18–28	1·88	3·62	4·99	6,200	·030	·054	2·35	68·34	23·78	0·39	0·38	v.l	v.l	v.l	v.l
C	28–40	1·80	3·26	5·36	2,800	·028	·047	2·31	68·79	22·76	0·79	0·49	m.	v.l	v.l	v.l
Queens Clay Loam—																
Cultivated	0–7	3·06	5·12	4·94	7,780	·085	·146	......	......	......	......	......	v.l	v.l	v.l	v.l
A_0	0–2	8·15	44·30	4·27	10,550	·969	·280	......	......	......	......	......	......	......	......	......
A_2	2–6	1·99	2·30	4·50	6,780	·040	·085	......	......	......	......	......	......	......	......	......
B_1	6–15	2·25	3·80	4·65	7,350	·056	·133	......	......	......	......	......	......	......	......	......
B_2	15–24	2·21	4·27	4·78	6,600	·051	·087	......	......	......	......	......	......	......	......	......
C	24–36	1·27	3·18	5·26	3,750	·030	·051	......	......	......	......	......	......	......	......	......
Queens Loam-Gravelly Phase—																
A (Cult.)	0–7	2·48	7·67	4·72	5,000	·136	·162	1·59	......	......	......	......	v.l	v.l	m.	m.
B_1	7–18	2·55	6·22	4·70	4,100	·101	·132	1·50	......	......	......	......	......	......	......	......
B_2	18–32	1·32	4·03	4·90	3,750	·038	·096	1·59	......	......	......	......	......	......	......	......
C	32–40	1·45	3·59	5·15	3,000	·023	·085	1·67	......	......	......	......	......	......	......	......
King Loam—																
Cultivated layer	0–7	4·22	13·90	5·15	6,200	·350	·204	......	......	......	......	......	m.	l.	v.l	m.
A_0	0–2	7·16	58·30	4·34	9,700	·650	·330	......	......	......	......	......	......	......	......	......
A_2	2–6	1·97	3·76	4·50	6,600	·068	·111	......	......	......	......	......	......	......	......	......
B_1	6–14	1·72	3·86	4·82	4,800	·043	·082	......	......	......	......	......	......	......	......	......
B_2	14–26	1·44	3·02	5·00	3,800	·028	·089	......	......	......	......	......	......	......	......	......
C	26–36	1·43	2·26	5·60	2,000	·017	·103	......	......	......	......	......	......	......	......	......
Kings Clay Loan—																
Cultivated layer	0–7	5·51	9·50	5·12	7,350	·240	·140	1·88	64·87	21·47	0·54	0·41	l.	v.l	v.l	v.l
A_0	0–2	6·38	45·00	4·23	12,950	·980	·334	1·41	37·81	12·16	0·49	0·19	......	......	......	......
A_2	2–4	5·71	9·90	4·20	10,400	·069	·179	1·90	68·71	16·82	0·43	0·23	......	......	......	......
B_1	4–15	2·60	4·50	4·38	6,780	·103	·064	2·10	71·24	19·43	0·39	0·27	......	......	......	......
B_2	15–22	1·82	3·42	4·78	5,480	·038	·089	1·58	71·08	22·13	0·50	0·64	......	......	......	......
C	22–36	1·68	3·92	4·98	5,330	·036	·048	1·62	72·57	21·34	0·41	0·34	......	......	......	......

TABLE 9.—CHEMICAL ANALYSES OF SOME TYPICAL SOIL PROFILES (Expressed on oven dry basis)—*Concluded*

Horizon	Depth	Hyg. moisture per cent	Loss on ignition per cent	pH	Lime requirement lb. Ca% p/a	N. per cent	P_2O_5 per cent	K_2O per cent	SiO_2 per cent	R_2O_3 per cent	CaO per cent	MgO per cent	Available P	Available K	Available Ca	Available Mg
	inch															
Ca leton Lo m—																
Cultivated layer	0–7	3·24	8·96	5·75	3,300	·305	·164	1·88	69·23	17·35	0·94	0·37				
A_0	1½–3	5·57	24·75	4·53	6,850	·481	·164	1·48	58·05	12·68	0·92	0·37				
A_2	3–5	1·31	2·58	4·60	5,600	·058	·058	0·88	86·12	9·99	0·50	0·28				
B_1	5–17	4·29	6·70	5·35	4,000	·095	·211	1·63	70·18	18·52	0·98	0·51				
B_2	17–31	1,38	3·15	5·66	1,800	·039	·091	2·48	71·44	19·40	1·05	0·61				
C	31–44	1·17	2·77	6·04	1,200	·024	·059	2·74	72·17	19·91	0·76	0·68				
Carleton Sandy Loam—																
Cultivated layer	0–7	2·75	9·82	5·07	4,000	·257	·170						v.l	v.l	m.	m.
A_0	1–3	5·07	27·60	4·02	9,150	·310	·241									
A_2	3–5½	1·81	3·84	4·06	9,080	·105	·065									
B_1	5½–15	4·66	9·07	5·08	4,200	·166	·215									
B_2	15–30	2·80	5·32	6·08	2,150	·091	·113									
C	30–40	1·33	3·45	6·10	1,400	·038	·100									
Carleton Clay Loam—																
A (Cult.)	0–8	3·07	8·95	5·60	3,900	·280	·190	2·37	69·95	16·86	1·28	0·36	l.	l.	m h.	m.h.
B_1	8–17	1·66	3·93	5·70	1,800	·073	·111	2·42	68·89	22·26	1·29	0·72				
B_2	17–32	1·23	2·58	5·85	1,500	·050	·099	2·42	68·71	24·35	1·37	0·66				
C	32–45	1·60	2·66	6·28	1,250	·029	·115	2·39	69·79	22·73	1·29	0·80				
Washburn Loam—																
Cultivated layer	0–8	2·16	8·53	5·84	2,700	·241	·147						v.l	v.l.	m.	m.h
A_1	2–4	5·49	23·80	6·28	4,600	·377	·230									
A_2	4–5	1·67	4·59	6·05	1,800	·098	·157									
B_1	5–15	0·71	2·27	6·48	1,000	·035	·131									
B_2	15–24	0·82	2·54	6·78	800	·025	·111									
C	24–36	1·13	2·77	7·05	0	·021	·141									
Washburn Clay Loam—																
A (Cult.)	0–8	2·36	7·89	5·67	2,870	·236	·134						m..	v.l	h.	h.
B_1	8–16	1·04	2·49	6·90	1,000	·053	·125									
B_2	16–27	1·30	2·67	7·28	720	·029	·127									
C	27–36	1·34	2·69	7·24	0	·030	·149									
agetown Gravelly Loam—																
Cultivated layer	0–6	2·54	3·63	5·32	4,750	·181	·174	1·65	77·89	14·29	1·36	0·07	1	v.l.	m.	v.l
A_0	0–2	5·91	37·77	4·14	10,000	·574	·153	1·59	45·33	13·18	1·29	0·09				
A_2	2–6	0·24	1·46	4·22	3,850	·032	·144	1·58	89·55	5·55	0·94	trace				
B_1	6–16	3·21	7·01	4·55	9,500	·059	·311	2·10	70·33	18·27	0·77	0·04				
B_2	16–24	2·62	3·73	5·15	4,400	·032	·356	2·09	72·84	18·99	1·11	0·07				
B_3	24–36	0·61	1·20	5·38	2,450	trace	·088	2·11	80·08	13·35	1·31	0·17				
C	36–45	0·53	1·08	5·40	1,000	trace	·056	2·10	82·98	11·21	1·15	0·17				

Gagetown Shaley Gravelly Loam—															
Cultivated layer	0–8	2·05	5·58	5·00	5,600	·103	·079	1·60	71·76	13·83	0·60	0·25	v.l	v.l	l.	v.l
A_0	0–2	4·41	23·62	4·32	8,250	·396	·132	1·57	55·40	17·76	0·78	0·11	....	....	....	....
A_2	2–6	1·01	3·73	4·28	7,150	·077	·042	1·56	76·91	16·12	0·59	0·17	....	....	....	....
B_1	6–16	2·36	5·59	4·85	6,600	·060	·131	1·70	60·02	30·97	0·60	0·36	....	....	....	....
B_2	16–28	1·65	4·47	5·00	4,180	·040	·097	1·52	64·48	28·89	0·56	0·31	....	....	....	....
C	28–40	1·24	3·87	5·11	3,800	·030	·060	1·65	65·65	27·35	0·95	0·30	....	....	....	....
Riverbank Sandy Loam—															
Cultivated layer	0–8	2·04	4·88	5·48	2,160	·143	·156	1·61	74·65	17·27	0·56	0·23	m.	v.l	v.l	l.
A_0	0–1½	4·08	33·40	4·43	8.200	·470	·217	1·52	53·30	10·49	0·66	0·14	....	....	....	....
A_2	1½–5½	3·03	7·90	4·46	4,100	·075	·129	0·64	76·76	12·72	0·38	0·06	....	....	....	....
B_1	5½–13	3·28	6·03	4·77	3,000	·129	·290	1·48	71·70	18·04	0·48	0·20	....	....	....	....
B_2	13–30	1·01	2·05	5·46	1,000	·046	·128	1·52	84·57	17·92	0·59	0·44	....	....	....	....
C	30–40	0·60	1·96	5·51	1,000	·032	·113	1·61	77·04	17·79	0·78	0·55	....	....	....	....
Internal Silty Loam—															
A (Cult)	0–10	1·12	5·51	6·28	1,800	·147	·196	2·26	....	....	....	....	l.	v.l	h.	h.
B_1	10–18	0·90	3·76	6·30	1,500	·113	·181	2·27	....	....	....	....	....	....	....	....
B_2	18–32	0·96	3·51	6·60	1,500	·087	·170	2·20	....	....	....	....	....	....	....	....
C	32–45	1·03	3·56	6·15	1,700	·083	·154	2·19	....	....	....	....	....	....	....	....

NOTE.—l. low.
m.—medium.
h.—High.
v.l—Very low.

SOIL SURVEY OF
FREDERICTON - GAGETOWN SHEET
PROVINCE OF NEW BRUNSWICK

Scale 1½ Miles to 1 Inch

1941

Base map compiled and drawn at the Hydrographic and Map Service, Labelle Building, Ottawa.
Map published by the Experimental Farms Service, Ottawa.

LEGEND
Classification of Soils

Podsol Zone

A. Soils on Glacial Till Derived from Sandstones and Conglomerates of the Middle Carboniferous (Pennsylvanian) Formation.

- (a) Well-drained Soils
  - I. Queens Series (Q.)
    1. Queens Loam — Ql
    2. Queens Sandy Loam — Qsl
    3. Queens Clay Loam — Qcl
- (b) Ill-drained Soils
  - I. Kings Series (K.)
    1. Kings Loam — Kl
    2. Kings Sandy Loam — Ksl
    3. Kings Clay Loam — Kcl
  - II. Cambridge Series (Ca.)
    1. Cambridge Loam — Cal
    2. Cambridge Sandy Loam — Casl
    3. Cambridge Clay Loam — Cacl
    - Undifferentiated

B. Soils on Glacial Till Derived from Shales, Slates and Sandstones of the Pre-Carboniferous Formation.

- (a) Well-drained Soils
  - I. Carleton Series (C.)
    1. Carleton Loam — Cl
    2. Carleton Sandy Loam — Csl
    3. Carleton Clay Loam — Ccl
- (b) Ill-drained Soils
  - I. Washburn Series (W.)
    1. Washburn Loam — Wl
    2. Washburn Clay Loam — Wcl
    3. Washburn Clay — Wc
    - Undifferentiated

C. Soils on Water-worked Parent Materials along River Channels and Valleys.

C1 - Soils on Gravelly Outwash, Kames and Eskers

- (a) Well-drained Soils
  - I. Gagetown Series (G.)
    1. Gagetown Gravelly Loam — Gl
    2. Gagetown Sandy Gravelly Loam — Gsl
    3. Gagetown Shaly Loam — Gshl
    4. Gagetown Gravelly Loam Hardpan phase — Glco

C2 - Soils on Sandy Parent Material on Slopes and Level Low Land

- (a) Well-drained Soils
  - I. Riverbank Series (R.)
    1. Riverbank Sandy Loam — Rsl
    2. Riverbank Loamy Sand — Rls
    3. Riverbank Sandy Gravelly Loam — Rsgl
    4. Riverbank Sandy Loam Silty phase — Rslsi
- (b) Ill-drained Soils
  - I. Oromocto Series (O.)
    1. Oromocto Sandy Loam — Osl
    2. Oromocto Sandy Silty Loam — Ossil
    - Undifferentiated

C3 - Immature Soils on Bottom Land Subjected to Periodic Flooding

- (a) Well-drained Soils
  - I. Interval Series (I.)
    1. Interval Silty Loam — Il
    2. Interval Silty Sandy Loam — Isl
    3. Interval Silty Clay Loam — Icl
  - II. Rusagonis Series (Rg.)
    1. Rusagonis Sandy Clay Loam — Rgsc
    2. Rusagonis Clay Loam — Rgc
- (b) Ill-drained phases of the Intervals and Rusagonis series are designated by attaching "I" — Ili - Rgcl

D. Organic Soils

- (a) Peat — P
- (b) Muck — M

E. Rough and Stony Land — RS

Other Soil phases

- Gravelly phase — g
- Stony phase — st
- Shallow phase — sh
- Ledgy phase — L